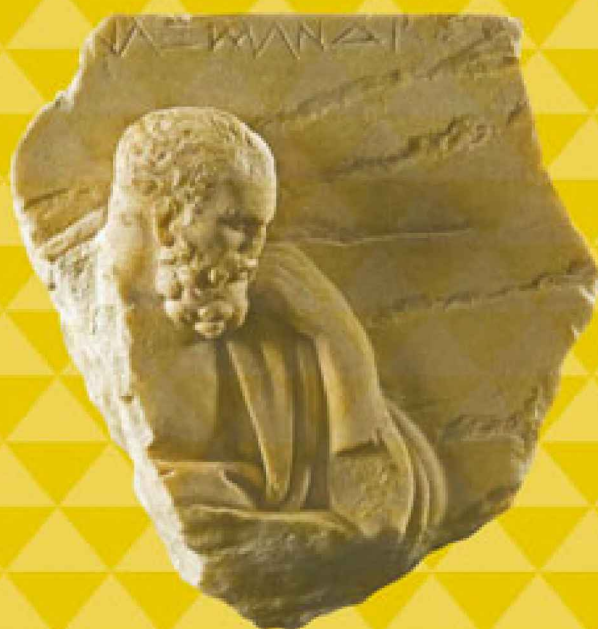


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ANAXIMANDER

A RE-ASSESSMENT



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For Sheelagh, with love

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Prologue

The prologue consists of three loosely philosophical anecdotes related to this book. When I was a Masters student, I attended a paper on Bayes' theorem, a view in the philosophy of science. Now in my opinion, Bayes' theorem is pointless, dull and excruciatingly tedious. In the middle of the audience was an eminent British philosopher who after five minutes of this paper was asleep, slumped back in their chair and snoring extremely loudly. Although I initially thought this rather rude on reflection, perhaps this was the proper philosophical response to Bayes' theorem. After all, nothing so dull and so tedious could possibly be true. I told this tale to a colleague, who related a converse experience. They gave a paper at Oxbridge, and after speaking, an elderly Oxbridge philosopher came up to them and said: 'Yes, young man, that was a very interesting paper, very interesting indeed. Interesting, and therefore wrong. The truth is always dull.' The reader will have their own view of these anecdotes, but beware – this book will at least try to be interesting.

On the Athens Metro, you can find warning signs which say *PROSOCHETON KENON*. Now *prosoche* simply means 'beware'. When I first saw one of these signs I had been writing on Leucippus and Democritus, where *ton kenon* is the infinite void. So my initial thought was that this meant 'beware of the infinite void'. Surely though, the infinite void would not fit into Monastriaki Metro station? And what danger was there in the infinite void anyway? This must mean something else, but what? Perhaps they had been reading Sartre, and I should prepare my soul for an encounter with the existential void? Is Monastriaki Metro station really that bleak and soulless? Or perhaps this is a Greek Orthodox Church slogan about the emptiness of life in the absence of God? Then the much more mundane answer dawned on me. As on the London underground, this simply means 'mind the gap' (between the train and the platform). There is a moral here somewhere about over-philosophising the Greek text, but whatever it is, I leave the reader to draw their own conclusions.

While teaching the ancient science module on our Masters programme, I was asked to explain Anaximander's *apeiron*. Well, I said, according to some

commentators it is entirely characterless and seemingly endless in extent. ‘Ah,’ replied one of my students, ‘just like visiting an IKEA warehouse then’ . . . This student will go far.

Andrew Gregory

August 2015

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I would like to thank Robert Hahn, Gerrard Naddaf, Dirk Couprie, Radim Kocandrlé, Jaap Mansfeld, Alex Mourelatos, Dan Graham, Norman Sieroka, Jason Jordan, and Jason Rheins for correspondence, conversations and sight of pre-publication papers concerning Anaximander.

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Introduction

This book will attempt a re-assessment of Anaximander's thought and some of the claims about him. Why should there be such a re-assessment? There has been a considerable amount of work on Anaximander of late, with some interesting new insights; I am interested in how these affect our overall picture of him. There have been some important recent advances in historiography which are relevant to how we look at Anaximander. I also feel that I have some new things to say, particularly about the zoogony, Anaximander's relation to his predecessors, the *apeiron*, the extant fragment and astronomy and cosmology. Where does this re-assessment lead us? In outline, to an Anaximander who relies more heavily on biological ideas in cosmogony and cosmology and for whom the idea that the *apeiron* steers plays a highly significant role. It leads to a simpler but more symmetrical and stable *cosmos* for Anaximander, one which displays considerable good order. Controversially, perhaps, it leads towards a single *cosmos* for Anaximander, rather than many worlds at the same time or many worlds in succession. It leads towards an Anaximander with fewer superficial similarities to modern scientific theories, but with theories of greater epistemic merit and contextual plausibility. Finally, it leads to an Anaximander who is self-consciously different from and critical of the preceding poets, especially Hesiod, but who is also significantly different from the early atomists. More than most works on Anaximander, I will be concerned with the criteria we use to reconstruct his thought from what little evidence we have and making explicit historiographical choices.

Anaximander's life and works

Anaximander lived from around 611/ 610 BCE to 547/546 BCE, being active at Miletus in Asia Minor, now Milet on the Anatolian coast of Turkey.¹ It is generally held that he was the pupil of Thales and the teacher of Anaximenes. Our best reconstruction of Thales' dates is 624 BCE–546 BCE, making him fourteen years older than Anaximander.² Our best reconstruction of Anaximenes' dates is 586/5–528/5 BCE, making him about twenty-five years younger than Anaximander.

Anaximander is often held to be the first Greek to produce a written account of nature.³ It is generally assumed he wrote one work though he may have written more. Whether Anaximander actually called his work/a work '*On Nature*' has been the subject of some debate. At this stage works were not always given proper titles and the title '*On Nature*' could have been imposed later.⁴ From what we know of Anaximander's work, '*On Nature*' would seem to be a perfectly reasonable title whether the work originally had that title. There is material on cosmogony, cosmology, astronomy, meteorology and zoogony. The comments of Aristotle would seem to indicate that Anaximander wrote principally on nature. We do have a list of Anaximander's works '*On Nature*', *The Circuit of the Earth*, *On the Fixed Stars*, *The Sphere* and some others,⁵ but these may be subdivisions of a single work rather than individual works themselves.⁶ I would at least entertain the possibility that Anaximander wrote several works.

Anaximander is reputed to have drawn a map of the world and to have been the first to have done so, at least among the Greeks.⁷ There is a Babylonian map, written on a clay tablet (BM 92687), which has been dated to the fifth century BCE, although it is thought to be a copy of an earlier map from the late eighth or seventh century BCE. The Babylonian map is a little more parochial than Anaximander's, with Babylonia the extent of the known world, but it is surrounded by salt water. Anaximander is sometimes credited with the invention of the gnomon, which can take the form of a simple stick, a triangle or a carpenter's square and is used for generating shadows from the sun.⁸ However, the Babylonians were aware of the uses of the gnomon well before Anaximander. We do not know precisely how much Anaximander travelled, but it seems he went to Sparta,⁹ and led a colony from Miletus to Apollonia.¹⁰

Anaximander and Historiography

We have relatively little evidence on Anaximander. What evidence we do have is open to a wide range of interpretations, so it is important that we are clear about the criteria for interpreting that evidence. This chapter begins by looking at some issues concerning how we attempt to reconstruct Anaximander's views and where we place him in the history of early Greek thought. These issues can interact in interesting ways and it is important to draw out and examine some assumptions that often remain tacit here. Most of our evidence on Anaximander comes directly from Aristotle, or from the doxographers and commentators who relied on him and the now largely lost work of his pupil, Theophrastus. The second half of this chapter looks at how reliable this evidence is and questions whether Aristotle and Theophrastus had full access to the written work of Anaximander. If they did not, that has considerable historiographical implications. I also want to investigate the possibility that there are two sources of evidence which we have not fully explored, based on the idea that Anaximander may have alluded to passages in Homer, Hesiod and other early poets and that some later Presocratics and Plato may have alluded to Anaximander.

Coherence

One aim of this book is to try to produce, as far as possible, an integrated, coherent view of Anaximander. There are two senses of coherence which we need to distinguish here. Couprie has commented that:

We must conclude that the tradition on Anaximander is to such an extent deficient that it is impossible to be reconstructed as a coherent whole. Our image of his work will always remain disrupted and incomplete.¹

The state of the current evidence is such that there are areas of Anaximander's thought of which we either know nothing or far too little, with no prospect of improving our knowledge. So in the sense of the totality of Anaximander's

thought, we cannot have a coherent whole. However, there may be a coherence, in the sense of fitting together consistently, of what we do know about Anaximander. From the principle of historical generosity, we ought to seek an interpretation of the evidence we have that gives such coherence. What sort of historiographical status does this integrated account of Anaximander have? Dicks, commenting on aspects of Anaximander's astronomy, has said that:

The unsatisfactory nature of the evidence, which is garbled and contradictory and has to be interpreted with arbitrary selectivity if a coherent account is to be obtained, makes it highly doubtful whether it has any historical worth, since there is no particular reason why one scholar's favoured interpretation should be any closer to the original than another's.²

I agree with Dicks that the evidence, both on Anaximander's astronomy and on some other aspects of his thought is 'garbled and contradictory', although I disagree that we have to interpret this evidence with 'arbitrary selectivity if a coherent account is to be obtained'. I would rather put it that we need conditional selectivity to sift the evidence. If we employ certain historiographical principles, then we can arrive at a coherent account. There are several senses in which these historiographical principles are not arbitrary. First, they can apply, in principle, to all the Anaximander evidence rather than be applied arbitrarily to some pieces and not others. Second, these historiographical principles have a specific form and either have been or can be applied to the interpretation of other early Greek thinkers in more general form. Third, these historiographical principles can be made explicit, their nature discussed and thus be opened up to criticism. Fourth, some of these historiographical principles have been the subject of much discussion, development and refinement. I take an important task of this book to be as explicit as possible about our historiographical choices in interpreting the work of Anaximander. Whether that makes my interpretation 'any closer to the original than another' is another matter, though I would point out that the issue of coherence is one that occurs with many thinkers and striving to produce a coherent, integrated account of someone's thought is standard historiographical practice. With the interpretation of Anaximander I am going to give, I do not claim that we can establish the interpretation of some fragments with certainty such that we can then deduce the interpretation of the rest of the fragments from them. I believe that good arguments can be given for the interpretations I advocate, without decisively ruling out other possibilities. We have relatively little material on Anaximander; what we do have is contested and the doxography is confused and often unreliable. It is not surprising that in such a situation, interpretations

are going to be underdetermined. The merit I claim for this account then lies in its coherence and integration. It may be that no such integration can be produced, which may reflect either on the nature of Anaximander's thought or on the extremely fragmentary state of the evidence we have about him.³ The project is worth attempting though, as long as we are aware of the limitations of the historiography.

Assimilations

I am going to try to steer a path between two different assimilations of Anaximander. I am opposed to assimilating Anaximander with Hesiod and hope to introduce a new line of argument which emphasises some of the differences between them. There is another tendency though, both in the ancient and modern worlds, to assimilate Anaximander with the early atomists, Leucippus and Democritus. In the modern world, this assimilation is sometimes made out of generosity to Anaximander. Leucippus and Democritus are sometimes seen as progenitors of important, progressive ideas. They introduce the idea of an infinite, empty space populated with many worlds. These worlds have come about through a physical, mechanical process, specifically through vortices and can be explained without any recourse to teleology. We can have a generous view of Anaximander if we can assimilate him with these sorts of views of Leucippus and Democritus. In the ancient world, this assimilation happened for two different reasons. This could come about through theological hostility, as Anaximander did not postulate a god separate from nature. More importantly, I argue that it came about through the doxographic tradition because of the way Aristotle represented Anaximander's views. While Aristotle, in my view, did not attribute multiple co-existent or successive *cosmoi* to Anaximander, it is easy to see how the doxographers thought he did. We at least need to be aware of these possibilities for assimilation and the motivation behind them and to look at the possibility of an Anaximander, with a distinctive view of his own, who lies between these assimilations. I also want to explore the idea that there are some interesting possible similarities between Plato and Anaximander.

There is another polarity here between organic and material accounts of cosmogony and cosmology in Anaximander. So it is possible to stress the organic aspects of the origins and nature of the *cosmos*, as Cornford does when he sees similarities between Anaximander and the Orphic egg. Alternatively, one can stress the similarities to early atomism in attempting to generate a largely

physical and mechanical view of Anaximander. Recent work allows us to dissolve this bipolarity if we wish. Organic metaphors for cosmogony and the working of the *cosmos* need not be seen as primitive; indeed they can be quite sophisticated. They are perfectly capable of supporting the law-like generation and behaviour of the *cosmos*.⁴

One view I will argue in this book is that the *apeiron* has an important function in Anaximander in 'steering'.⁵ How the *apeiron* does this, what the nature of this steering is and how extensive its effect will all be issues to consider. If the *apeiron* does steer, this need not compromise the law-like and invariant behaviour of the *cosmos*; rather it can underpin it. It is interesting that in some work on Anaximander, particularly pieces arguing for a secular/scientific view, steering is barely mentioned, indeed in some pieces it is ignored entirely. Two alternatives I will canvass will be that the *apeiron* manages (a) a form of what is currently called 'intelligent design' and (b) some form of organic growth in the sense that a seed steers the growth of a plant. I have important new evidence that steering is ongoing (it does not just occur in an early part of cosmogony) and is thoroughgoing (affects all aspects of the *cosmos*). Both of these attributes have been denied in the literature.

Some commentators have also argued for an early form of Darwinian evolution in Anaximander. I will argue that this is mistaken. I want to make it clear here that I am not arguing either of these views, on the *apeiron* or evolution, from the perspective of a modern supporter of intelligent design. So I do not see here something I approve of in Anaximander or seek to give some sort of legitimacy to intelligent design by finding its ancient forms. The issue for me is whether we can make better sense of Anaximander if we give the steering theme some more prominence and how we understand steering to work for Anaximander.

Anaximander the first?

Some bold claims have been made about Anaximander as the first philosopher, the first scientist, the first rational thinker, the first cosmologist etc.⁶ This may be useful for selling books (X, the first y) but I have my doubts as to whether this sort of description is particularly enlightening. One question here is what such an attribution says about those who came before. I have argued elsewhere that it would be quite wrong to treat them either as irrational or entirely lacking in rationality and would instead argue something similar in relation to philosophy

or the investigation of nature.⁷ A second issue is that philosophy, science, rationality etc. are complex and contested notions and that any attribution of 'the first' is going to be highly definition dependent. Often that definition is not universally shared and the discussion becomes more about the definition than the person that 'the first' is being attributed to. There is also a temptation for 'the first' narratives to become hagiographic. One more local problem with Anaximander is that any 'the first' attribution can plausibly be attributed to Thales as well, which makes matters more complex given that we know relatively little about him. I prefer to think of the origins of philosophy, science rationality, etc. less as a point from which they proceed in a straight line directly towards our modern conceptions, more as a multiple system of roots which join to form the main trunk of these disciplines. The point at which the roots become the trunk is then a less clear and a less interesting question than the nature of the roots and the soil they spring from. I take Anaximander to be an important (but not the sole) root and have an interest in the soil from which this root emerges. One issue with the point and line model is that it rather invites 'Greek miracle' narratives of how this point and subsequent line heading in our direction suddenly appear in ancient Greece.⁸ This is not to say that Anaximander did not have some important original contributions to make, especially in cosmology. Those though are more specific and more easily identified. So this book will be making no grand 'Anaximander the first' attributions but will be interested in his more specific innovations and in the background for Anaximander's thoughts.

Anaximander and his predecessors

Let me begin here with a view of Anaximander which I would like to oppose. West has commented that:

We can still see that Anaximander for his part was no vigorous rationalist. He allowed divinity an important place in his universe, major parts of his system had a visionary rather than a logical foundation, and he explained certain cosmic changes in terms of 'injustice', 'retribution', 'ordinance', language which Simplicius calls 'rather poetic' (DK12B1) but which it is much more meaningful to classify as theological.⁹

First, it may be that Anaximander did allow divinity to play an important part in his system. Whether that affects his credibility as a 'vigorous rationalist' is another matter entirely. He may have had rational arguments for supposing the *apeiron*

to be divine and the supposedly divine *apeiron* may have acted in an entirely invariant manner. Clearly, much depends on what is meant by 'divine' here and what sort of role the divine plays for Anaximander. This is something I will look at in detail. To throw down a historiographical marker though, I reject the 'conflict' historiography of the relation of science and religion which has been so influential up to the last twenty years or so. The notion that science and religion are always and have always been in conflict was a construction of late nineteenth-century historians such as Draper and White; this has now been widely rejected in favour of the complexity model.¹⁰ It is important because it allows us another perspective on Anaximander. On the one hand, it is possible to argue that Anaximander did not consider the *apeiron* to be divine or to downplay the role of the divine in Anaximander, thus preserving his rationality and naturalism.¹¹ On the other hand, one might accept that the divine has a significant role to play in Anaximander and give up the rationality and naturalism claims. The view I will argue for here is that we can accept that Anaximander gave an important role to the divine without compromising claims for his rationality and naturalism. Anaximander is best seen as advocating a form of pantheism where the divine is identical to nature.

Second, I disagree that parts of Anaximander's system had a 'visionary rather than a logical foundation' or, as Barnes has put it, that it 'was worked out with a dedicated mixture of mathematics, insight and fantasy'.¹² I disagree with Barnes on the fantasy element. The usual foci here are Anaximander's cosmogony and zoogony. Here I will emphasise his uniformitarianism and the idea that these processes are modelled on processes that we can see around us in the world today. A major theme of this book will be that Anaximander's theories were based more on observation than they are often given credit for. While he was no experimentalist in any modern sense, neither were his theories unconstrained flights of fancy. A related theme will be that Anaximander was aware of and used a good deal of folk knowledge as a basis for some of his theories.

Third, Anaximander did indeed explain certain cosmic changes in terms of 'injustice', 'retribution' and 'ordinance' though, as we will see later, I believe there are some better translations for these terms. I do not see such language as being necessarily theological, especially if we are going to see Anaximander advocating a form of pantheism. Rather, I will argue, Anaximander is trying to express the invariance of physical processes. He does not have access either to the modern concept or the vocabulary of mathematically expressed physical law with which to do so. Like many before the scientific revolution of the seventeenth century, he uses the language and concepts of civil law for physical processes.

Anaximander the pre-Parmenidean?

It is important that we recognise that Anaximander was a pre-Parmenidean thinker.¹³ Sometimes that is taken to mean that Anaximander lived prior to the radical arguments and conclusions of Parmenides and so we should be careful before attributing any outlandish position to him.¹⁴ We can be rather more specific than this. Parmenides introduced an interest in the nature of existence and the nature of negation though that does not get us far in relation to Anaximander. More importantly for us Parmenides introduced considerations concerning change and plurality. If we are going to attribute to Anaximander views similar to those of the early atomists (on space or plurality) or Anaxagoras (on mixture), which I take in large part to be replies to Parmenides on plurality and change, we need to ask what would have motivated Anaximander towards those ideas in a pre-Parmenidean context? Where there is possible doxographic evidence for those views we need to question the motivation of Aristotle, Theophrastus and the doxographers especially as they may have had fewer historiographical scruples in relation to Anaximander than we do. A second important consideration here is sufficient reason. I have argued elsewhere that Parmenides posed problems of both when and where cosmogony begins within his general concerns about change.¹⁵ Anaximander, I believe, did use a sufficient reason argument, in relation to the stability of the earth and the *cosmos* more generally. However, I think this was different both in nature and in context from the early atomists' reply to Parmenides, which I have argued elsewhere was to say *ou mallon*, there is no preference, in relation to the spatial/temporal location of vortex/cosmos formation in the void.¹⁶ Again, if we attribute *ou mallon* in relation to cosmogony, or other related ideas to Anaximander, we must query the motivation for those ideas prior to Parmenides.

Theory quality

There is a question about the quality of the theories which Anaximander put forward. I have addressed this more generally in my *The Presocratics and the Supernatural*,¹⁷ but wish to revisit this issue here in more detail in relation to Anaximander. Lloyd has commented, specifically for the Hippocratics but also for 'Presocratic natural philosophers'¹⁸ more generally, that:

It was a mere act of faith – we might even say bluff – to claim to be able to explain, let alone control, the phenomena in question.¹⁹

The standard counter to this is that the new natural theories of the Presocratic natural philosophers were at least the right type of theories and that better explanations would follow. Lloyd's counter to this is that how natural explanation should be pursued was not in the least part clear and was contested, both in terms of content and methodology.²⁰ I will argue that Anaximander's natural theories had significant epistemological merit and there was more than an act of faith involved here.²¹ One move here will be to argue that Anaximander's theories had considerably more observational support than is commonly accorded to them. I will also argue that Anaximander drew on knowledge from folk and craft traditions, both in his zoogony and his cosmology. Another move will be to argue that there are important structural similarities between Anaximander's theories which point to important decisions being made about the nature of the sort of theory he wishes to construct.

Continuity or change?

There has been considerable debate about the relation of Anaximander to Homer and Hesiod, and to the preceding mythological tradition in general. So, for instance, Kahn compares:

The radical contrast between the physical ideas of Homer and Hesiod on the one hand, and those of Anaximander and Anaximenes on the other.²²

Cornford says this of Hesiod's cosmology:

Only a very thin partition divides it from the early Ionian systems.²³

Kahn comments that:

The recent tendency to assimilate Anaximander to Hesiod – which underlies Cornford's brilliant treatment of him in *Principium Sapientiae* – can only serve to blur the distinguishing features of each, by confounding the very different attitudes toward Nature that characterize the Greek epic poets and the early philosophers.²⁴

The first thing to say here may seem obvious but is, nevertheless, worth stating. The issue is where we place Anaximander on a spectrum of continuity and change, rather than whether Anaximander is entirely continuous or discontinuous with his predecessors. Clearly, there are aspects of both continuity and change in relation to his predecessors.²⁵

Having said that, I have something radical to say about Anaximander's meteorology and his relation to Hesiod. This is that the 'Concerning thunder,

lightning, thunderbolts, hurricanes and typhoons' passage is a direct allusion to Hesiod's *Theogony*.²⁶ Where Hesiod explains these phenomena in terms of the gods, Anaximander treats these phenomena as entirely natural and cites only natural entities in their explanation. If there is allusion here, this is a conscious move on Anaximander's part. He does not mention a few random phenomena which Hesiod deals with in different places, but specifically mentions five from a single important passage in Hesiod and gives a radically different explanation for them. I will also argue that the allusion here fits into a pattern preceding poets in Anaximander, with important further allusions to Hesiod and to Homer, Solon, Terpander and Theognis. That, arguably, is part of a broader Presocratic tradition of allusion and critique of the early poets. One criticism one might make of this approach is that there is so much poetry prior to Anaximander that it is possible to find some similarities between some poetic passage and parts of Anaximander. My reply to that is that Anaximander's allusions to poetry appear (a) to be many and systematic, pushing strategically similar points; and (b) appear to produce a pattern we would not expect to see if this was just a random effect.

Transformation

Hahn has commented that:

Anaximander is first and foremost a transitional thinker.²⁷

In many ways I think this is a perfectly sound thing to say. Clearly, there is an important new pattern of thought in ancient Greece, with the establishment of Presocratic philosophy and science against the background of the mythologies of Homer and Hesiod. Anaximander plays an important part in that, but could not be said to have generated all of that new pattern of thought; in that sense he is a transitional thinker. However, I have a concern that this expresses matters too passively for Anaximander. I also want to have in play the idea that he is a transformational thinker.

So instead of being someone caught up in a transition, or being swept along by it, Anaximander is more active in shaping this new tradition and setting its agenda, and in being critical of Homer and Hesiod, or of transforming aspects of their thought. This will be important in my account of Anaximander's relationship with Hesiod in particular as I see him actively trying to transform previous thinking. In relation to this, I am not committed to a simple *muthos* to

logos, myth to reason account of the development of early Greek thought. There are important changes, but they are not simple, unidirectional or linear.²⁸ The latter point is significant in relation to Anaximander, as he is usually grouped with Thales and Anaximenes. Is there a necessity to place Anaximander in the middle of some supposed linear progression from Thales to Anaximenes? In my view: no. That is an important historiographical consideration as some modern commentators use the idea of a linear transition through Thales, Anaximander and Anaximenes as a constraint on the sorts of interpretation they are willing to consider.²⁹ It is important here not to impose a premature or inappropriate unity on the Milesians who may each seek a transformation on their own manner.

Anaximander and *phusis*

Aristotle talks of *hoi phusikoi*,³⁰ ‘the naturalists’ and Plato speaks of *peri phuseôs historian*, the ‘enquiry concerning nature’.³¹ The Greek word *phusis* has a broad range of meanings. It can mean nature, in the sense of the nature of something or somebody, or nature in the sense of the natural world.³² It also has important connotations of origin and growth,³³ ‘the natural form or constitution of a person or thing as the result of growth’.³⁴ As is now standard, I take the Presocratics to be thinking about the origin and growth of something as well as its current nature when they talk of the *phusis* of something.³⁵ Was Anaximander one of the *phusiologoi*, literally ‘those who talk about nature’? I raise this question for two reasons. First, we do not find the term *phusis* being used by Anaximander in any of our sources.³⁶ Is it then proper to consider him to be one of the *phusiologoi*, or rather as an important contributor to the *phusiologoi* tradition? I believe that Anaximander both talks about the sorts of things that the *phusiologoi* tradition talks about and talks about them in the same sort of way.

The second reason I raise the issue of whether Anaximander was part of the *phusiologoi* tradition is to highlight an issue in translating *phusiologoi* and its cognate terms. In my view it is a significant error to translate the Greek *phusiologoi* as ‘physical philosophers’ or even ‘physicists’.³⁷ A very few Presocratic thinkers may have been physicalists, mechanists or materialists as we understand the terms, but most were not. Some had a more organic concept of nature while many used biological analogues for the processes they saw around them. I include in this Leucippus and Democritus, the early atomists, who used biological analogues for the birth of *cosmoi* and who used biological and agricultural

analogues for the like-to-like effect that is found in vortices and is again fundamental to *cosmos* formation.³⁸ Even amongst recent authors sympathetic to the idea that Anaximander had an organic or biological conception of the *apeiron*, there are instances where Anaximander or the Presocratics are referred to as physicists and the functions of the *apeiron* are referred to as mechanical.³⁹ So Babut comments that Anaximander:

Substitue un processus de séparation purement mécanique des éléments constitutifs du monde à la generation.⁴⁰

In my view Anaximander had a biological conception of both the *apeiron* and the *cosmos* and a non-reductive one at that. It was not biological at one level, which could then be explained in terms of underlying mechanisms, but one that was irreducibly biological.

This more organic and biological approach to nature did not prevent some Presocratics from having an invariant conception of nature or giving explanations citing only natural entities. I have argued elsewhere that the Greeks used biological analogues for invariant behaviour.⁴¹ For the ancient Greeks the very notion of *phusis* is effectively an organic one of growth, so biological analogues for them are simply not going to be non-natural. The view of Anaximander that I will argue for is that of someone who is not a physical philosopher but a natural philosopher. It is important that we recognise that there can be such a thing. It is also important to recognise that such a person would be a full part of the investigation of nature tradition.⁴²

One issue here is whether the *apeiron* is part of *phusis* for Anaximander. My answer to that is a simple yes, as *phusis* includes the origins and development of the world we see around us and that world clearly originates from the *apeiron*. Some commentators, either implicitly or explicitly, have denied the *apeiron* as part of *phusis*; this has some important implications for how we interpret Anaximander. A strategic argument of this book will be that Anaximander addressed all of the issues one would expect of someone investigating *phusis*. This is reflected in the chapter headings (zoogony, meteorology, *apeiron*, cosmogony, etc.) with the intention of building an overall picture of someone who is dealing with all aspects of *phusis*.

Anaximander's *cosmos*

I shall use the transliterated *cosmos* (plural, *cosmoi*) throughout this book for the Greek κόσμος. I do this to try to preserve the ancient Greek notion of *cosmos*, a

well-ordered entity, perhaps even an aesthetically or even morally good entity, which can be lost if we translate *cosmos* as universe or world, or even *cosmos* in the modern sense.⁴³ Is it proper to speak of Anaximander's *cosmos*? In my view, yes. It can be questioned whether the term *cosmos*, in the sense of a well-ordered world, dates back to Anaximander.⁴⁴ Prior to Anaximander, the word usually indicated something that was well done or well ordered,⁴⁵ though we do not have full proof of *cosmos* being used to mean a well-ordered world until after Anaximander. I agree with Kahn that:

kosmos is the word invariably used by later authors to denote the organic view of the natural world we have traced back to Miletus and to the fragment of Anaximander.⁴⁶

I am not overly concerned with whether or not Anaximander used the term *cosmos*. What will become clear is that Anaximander's conception of how the universe is put together meets all the criteria for a Presocratic *cosmos*.⁴⁷

The nature of Anaximander's *cosmos* will be an important issue. One recurring theme will be that Anaximander's *cosmos* exhibits a great deal more *taxis* (order) than is generally recognised. The heavenly bodies have a very specific and intricate structure and organisation which gives them remarkable stability. Here, I disagree with Mansfeld who has recently said that:

According to our witnesses the required stability is hard to find, both at the beginning and in a future stage of the career of Anaximander's *cosmos*.⁴⁸

I will argue that the stability is there to be found, even if this is not something which is stressed by the doxographic tradition, or indeed by modern commentators. An important question then is how does the *cosmos* acquire and maintain this degree of *taxis*? I argue that the steering principle is critical here. A second recurring question will be that if Anaximander has set up his *cosmos* with such a remarkable degree of *taxis* and stability, why would it ever decay?

It is important that we consider Anaximander's system in a broad perspective. So, for instance, it is not adequate to consider the stability of the earth as a question on its own. There are also issues about the stability of the celestial rings which surround the earth and even of the stability of the *cosmos* within the *apeiron*. Some candidate theories for the stability of the earth simply do not function on the broader scale. This will also be important in relation to the extant fragment, where I argue that we take the changes referred to too locally where a *cosmos*-wide perspective can give some interesting new approaches to understanding this passage.

The Anaximander doxography

We have one sentence which we believe to be written by Anaximander, though even that is a report of a report, rather than a direct quotation. Simplicius, our source, is relying on Theophrastus and it is not clear if Theophrastus had direct access to Anaximander's written work or not. The earliest generally recognised source we have for a description of Anaximander's views is Aristotle, though even here we are talking of a significant gap of time. The standard dating for Anaximander is 611/610 to 547/546 BCE, while Aristotle lived from 384 to 322 BCE. So there may well be 250 years between Anaximander's writing and Aristotle's writing on Anaximander.

There are well-known problems with Aristotle's treatment of the Presocratic thinkers and of the Milesians in particular. The basic concern is that Aristotle was not primarily a historian of philosophy. He gave summaries of his predecessor's views on a topic before giving what he thought were the shortcomings of these views and then arguing for his own position. Aristotle had a tendency to interpret his predecessor's views in terms of his own system of thought, which in some cases led to serious misrepresentation. Aristotle was not always as precise and careful as we might wish in specifying who thought what. That has some important consequences for trying to reconstruct Anaximander's views.

Aristotle's pupil Theophrastus wrote *Phusikôn Doxai*, 'The Opinions of the Natural Philosophers'.⁴⁹ This was an immense work, reputedly of 16 volumes, of which much of the original has been lost. What we know of it indicates that it suffers from some of the same problems as Aristotle as a source. Theophrastus' intent, as with Aristotle, was not so much historical accuracy as setting out views as part of a search for the truth about nature. Theophrastus also had a tendency to represent Presocratic views in Aristotelian terms.⁵⁰ While we know that Theophrastus can be accurate and that he can at times take a different view to that of Aristotle,⁵¹ in my view it is also the case that Theophrastus (and those who followed him) could take some of the less precise sayings of Aristotle too literally with subsequent distortion. A great deal of the subsequent doxography is dependent on either Theophrastus' *Phusikôn Doxai*, or on the works of Aristotle.

To some extent we can reconstruct Theophrastus from five later sources. All have their own agenda, all have their own idiosyncrasies and while all are, to some extent, useful, none should be taken as definitive in reproducing Theophrastus, less still Anaximander. We have the works of Simplicius

(c. 490–c. 560 CE), the neoplatonist commentator on Aristotle and in particular his *Commentary on Aristotle's Physics*. Simplicius is a very good source, sometimes giving us direct quotation of Presocratic material which would otherwise be lost and is a good source on Theophrastus. We have *The Refutation of All Heresies* by the theologian Hippolytus (170–235 CE) and *Preparation for the Gospel*, usually known as *Preparatio Evangelica* by Eusebius (c. 265–c. 339 CE), who reproduced Pseudo-Plutarch's *Stromateis* on Anaximander. Both are useful sources but both have an agenda as can be judged from the titles of their works. We also have the works on the history of philosophy of Pseudo-Plutarch (c. C3–4 CE) and Stobaeus (c. C5 CE). Diels argued that they have a common source, a doxographer from the Hellenistic period called Aetius.⁵² Sometimes passages are quoted by their Aetius page numbers. I am not entirely happy with that because in places we have parallel passages from Pseudo-Plutarch and Stobaeus and sometimes these have minor differences of wording. Often this is not too important, but in some places it can be of great significance, so I will quote Pseudo-Plutarch and Stobaeus references and give both passages where necessary. They both arrange their material by topic, and by quite specific topics, rather than by person.

Further, less useful sources for Anaximander's thought are Diogenes Laertius and Cicero. Anaximander is given a short section in Diogenes Laertius (c. C3 CE), *Lives of the Philosophers*, 2, 1–2. Diogenes is a useful source of information, but he is more interested in biography and anecdote than in constructing an accurate history of philosophy. Cicero (106–43 BCE) also has some information as, to a lesser extent, do Seneca and Censorinus.

The texts of Aristotle, Theophrastus and Anaximander

It is often assumed that Aristotle and his successor Theophrastus had access to the written works of Anaximander. That is possible, but by no means certain. Kahn says that:

Although his book was still available to Apollodorus, who made use of it in his chronology, it is not known to have been consulted by any other writer later than Aristotle and Theophrastus.⁵³

Apollodorus of Athens was born in 180 BCE. The source for our Apollodorus having the written works of Anaximander is Diogenes Laertius, who tells us that:

He (Anaximander) made a summary exposition of his own views, which Apollodorus of Athens somehow came across.⁵⁴

That 'Apollodorus of Athens somehow came across' this work by Anaximander and that no-one else made use of it after Aristotle and Theophrastus would suggest that it was not commonly available. Was it available to Aristotle and Theophrastus? This is an important question, for as Kirk says:

Theophrastus is regarded as infallible because, it has always been maintained, he had Anaximander's book in front of him. This is, in fact, nowhere asserted by Theophrastus or any other ancient source.⁵⁵

Kirk gives a collection of arguments about Theophrastus' knowledge of Ionic works, commenting that as none of these arguments are compelling in themselves, the case must be regarded as a cumulative one.⁵⁶ This is a summary of Kirk's arguments:

1. Theophrastus wrote individual works on Anaximenes, Empedocles, Anaxagoras, Archelaus and Democritus, but not Thales, Anaximander or Heraclitus.
2. Whatever Thales put in writing was not known to either Aristotle or Theophrastus.
3. The surviving fragment of Anaximenes is not in Ionic, the dialect that Anaximenes wrote in.
4. Theophrastus did not write a work dedicated to Heraclitus and appears to be relatively poorly informed about him.
5. It is surprising that Theophrastus does not have more to say on Heraclitus' views on sensation in his *De Sensibus* if he had reasonably full access to Heraclitus' works.
6. That Apollodorus 'came across' a summary exposition of Anaximander's views does not mean that either a full or partial account of Anaximander's views were available to Theophrastus.
7. Theophrastus is comparatively well informed on Anaximander's astronomy, meteorology and anthropogony, but seems much less well informed on the basic principles and the unlimited for Anaximander.

Kirk concludes that:

These considerations indicate that we are not entitled automatically to assume that prose works written in Ionia in the sixth or early fifth century were still available in their entirety to Theophrastus. In the case of Anaximander I would suggest that what Theophrastus might have had in front of him was not a complete book but a collection of extracts, in which emphasis was laid upon astronomy, meteorology, and anthropogony rather than upon the nature and significance of *to apeiron*, which might always have seemed confusing.⁵⁷

Here I would raise another possibility, that Anaximander wrote several works, not a single one and that Aristotle and Theophrastus either had only one, or a limited number in front of them. I take a more radical view than Kirk on this issue though, which involves the question of oral transmission and also asks the question of Aristotle as well as Theophrastus. The sentence and a half which purport to be Anaximander's own words may have been orally transmitted. The rest of what we have in Aristotle and Theophrastus may simply be drawn from oral transmission as well. If we take the standard view that either Thales wrote nothing, or if he did it was not available to Aristotle, then there must be such oral transmission of Thales as Aristotle is able to give us a reasonable précis of his views, and arguably gives us a short memorable quotation of 'all things are full of Gods'.⁵⁸

That Simplicius says that Anaximander wrote in a poetic fashion can cut both ways. It might be taken as confirmation that someone (Aristotle, Theophrastus, Simplicius?) has seen enough of Anaximander's written work to make that judgement. However, it might refer only to the fragment that we have and might be an explanation as to why we have only this fragment. This fragment was written in a poetic manner and so was better suited to survive oral transmission, especially in a culture where poetry was important in oral transmission.⁵⁹ I would add some more considerations to those of Kirk:

1. If Aristotle and Theophrastus had the text of Anaximander in front of them, why do we have no quotations from Anaximander at all in Aristotle and only the one that we know of in Theophrastus? One would certainly expect more direct quotation, especially as other Presocratic philosophers are quoted.
2. In particular, at Aristotle, *Physics*, I/4, 187a20 ff. Aristotle mentions three thinkers for whom opposites emerge by separation, Anaximander, Empedocles and Anaxagoras. Yet in the ensuing lengthy discussion, only Empedocles and Anaxagoras are discussed.
3. Similarly, at Aristotle, *Physics*, III/3, 203b10 ff. Aristotle discusses Anaximander's views but one would expect much more detail here if Aristotle had the text, perhaps even quotation, while all we have are two phrases (surrounds all and steers all, immortal and indestructible) which may be Anaximander's words.
4. At *On Generation and Corruption*, II/1, 329a5–15, Aristotle discusses the elements and produces the argument that: 'The *apeiron* must of necessity be light or heavy or hot or cold.' If Aristotle had access to his texts, we might

expect some reference to Anaximander here, but what we get is that 'What is written in the *Timaeus* is not well defined.' In fact, Anaximander is not mentioned by name in either *On Generation* or *Corruption* at all.

5. There are some discrepancies between the accounts of Aristotle and Theophrastus which would suggest that they are not both reading from the same text.⁶⁰ Aristotle uses ἐκκρίνεσθαι for generation from the *apeiron*, while the doxographic tradition relying on Theophrastus has ἀποκρίνεσθαι.⁶¹ Theophrastus has a different account of the *apeiron* as a mixture, Aristotle making Anaximander very like Anaxagoras and Empedocles. It would be odd to assume that one had the text before him while the other did not. More plausible perhaps is the idea that neither had the text and the discrepancies are down to the vagaries of oral transmission. In relation to this point, there is an important methodological issue here. Scholars who believe that Aristotle and Theophrastus had the texts of Anaximander to work from have worked very hard to synchronise their views and explain away any discrepancies. I am more open to the possibility of some dissonance between them. One issue here is that there are passages in Aristotle which may or may not give Anaximander's views but where Anaximander is not mentioned by name. Do we simply rule out all those that disagree with Theophrastus and rule in all those which do?⁶²
6. There is a confusion in the doxography which it is hard to believe would have arisen had the original texts been available to Aristotle and Theophrastus. This is the question of whether the *apeiron* is intermediate between two elements (either air and fire or air and water) or is different from the elements. No modern commentator gives any credence to the intermediate view.⁶³
7. It is unclear in Aristotle and the doxography as to whether Anaximander spoke of *to apeiron*, the *apeiron*, with the unlimited treated as a substantive, as is generally assumed or whether he spoke of an unlimited something, with unlimited as a predicate of something else.⁶⁴ One would expect more precision if the text were available but this sort of confusion with oral transmission.
8. It is notable that Theophrastus did not write a work on Thales, Anaximander or Heraclitus. Why these three? Perhaps he did not have any original written texts. So a possible hypothesis here would be that Thales wrote nothing, Anaximander wrote something which was lost before Plato and that Heraclitus' 'book' was a later collection of his aphorisms.⁶⁵

Against this one might argue that while Aristotle makes it clear that he has only hearsay evidence in relation to Thales, he does not make that clear in relation to Anaximander. So at *De Anima*, I/2, 405a19, Thales 'from what is remembered' holds that the soul is a motive force and at *Metaphysics*, I/3, 984a2 Thales 'is said' to have believed this about the primary cause. In reply to that, Aristotle does sometimes but by no means always indicate that his evidence on Thales is hearsay and we may not have enough evidence of a possible differential treatment of Thales and Anaximander to make a definitive judgement here. At no point does Aristotle indicate that he has read Anaximander, as he does with others. It is also notable that at *De Caelo*, II/13, 295b10 ff. that Aristotle refers to the indifference theory of the earth's stability 'as with Anaximander among the ancients'. That may indicate simply that Aristotle recognises Anaximander as an early thinker, though combined with a lack of detail or quotation here (Aristotle gives us less than Plato does in the *Phaedo*) it may indicate that Aristotle did not have the text of Anaximander available.

One might object to the oral transmission thesis that there is too much detail, too consistently reported for this material to have been transmitted orally. I do not see that we have anything from Anaximander that shows so much detail that it could not have been transmitted orally. There is a great deal more detail transmitted concerning the work of Homer, a tradition we know to be oral. On consistency, the doxographic tradition is consistent on some aspects of Anaximander, but I take this to be due to the fact that they treat Theophrastus as their main source of information. While I accept that Aristotle occasionally made errors in his use of documents⁶⁶ or perhaps relied too heavily on his memory when quoting,⁶⁷ I do not think this is enough to account for the lack of quotation and discussion of Anaximander in Aristotle, the discrepancies in relation to Theophrastus or the confusion on the nature of the *apeiron*.

There has been a recent discovery of a fragment of the catalogue of the library at Taormina in Sicily. This lists 'Anaximander, son of Praxiadēs of Miletus' so it would seem that something from Anaximander was preserved in that library.⁶⁸ Quite what was in the library is another matter and could range from the full works of Anaximander to a simple summary of his work. This is interesting, and perhaps gives extra credence to Apollodorus 'coming across' a summary exposition of Anaximander's views. I do not see that it has any bearing on whether Aristotle and Theophrastus had the text of Anaximander available to them.

This is not an oral composition thesis about Anaximander. The hypothesis is that Anaximander wrote but his work was lost, in whole or in part, and there was

an oral tradition which preserved some of what he had written. I leave open the Havelock question of whether Anaximander composed his work under a 'form of audience control',⁶⁹ orientated to a listening rather than a reading audience.⁷⁰ We do not have enough of Anaximander's work to answer this question definitively, though Simplicius' comment on the extant fragment, 'as he says in a poetic fashion'⁷¹ is enough to indicate that this is a live issue. Finally, this is a suggestion about how Plato, Aristotle and Theophrastus have knowledge about Anaximander. I take the later doxographic tradition to be dependent on the written work of Theophrastus and Aristotle in the normal manner.

Evidence

If it is the case that neither Aristotle nor Theophrastus had sight of the text of Anaximander, then we might have doubts about whether we know much about Anaximander at all, given that so much of the subsequent doxographical tradition is so heavily dependent on Aristotle and Theophrastus. Does this not undercut virtually all the evidence we suppose we have about Anaximander? In a sense it does, though this is more subtle than a move from evidence which is entirely reliable to evidence which is entirely worthless.

It should be clear that the evidence we have from Aristotle and Theophrastus, whatever the nature of the sources they are working from, is not infallible. There are the usual issues with Aristotle's representation of Presocratic philosophy. I agree with Kirk that:

Theophrastus is heavily dependent on Aristotle's Presocratic interpretations, and should not be unthinkingly accepted as an independent source.⁷²

In some places Aristotle and Theophrastus' evidence seems confused and even contradictory,⁷³ as is the doxography.⁷⁴ Aristotle and the doxography can get interpretations seriously wrong.⁷⁵ The classic case here is Heraclitus and successive worlds. We are told that Heraclitus believed in successive *cosmoi*, while the modern orthodoxy is that Heraclitus believed in a single *cosmos* without beginning or end. Even if we suppose that Aristotle and Theophrastus had access to Anaximander's texts, we still have to make judgements about what we wish to accept, and making those judgements is possible.

If there was oral transmission we have no less evidence than we did before. We still have everything written by Aristotle and Theophrastus and the following doxographical tradition, even if the nature of that evidence may be slightly

different. What I want to stress here is that the recognition of the possibility of oral transmission offers an important opportunity for re-assessing that evidence and for looking for other types of evidence in relation to Anaximander.

Aristotle and Theophrastus

There are of course good reasons to group Aristotle and Theophrastus together, Theophrastus being a pupil and philosophical follower of Aristotle, employing largely the same peripatetic conceptual framework and arguably being engaged upon similar projects of detailing and criticising predecessor's views as a precursor to discovering the truth on an issue.⁷⁶ However, they do not give us identical accounts. Theophrastus gives us information which Aristotle does not. Is Theophrastus better informed than Aristotle? Kahn has said that:

Any apparent disagreement between the two writers may almost invariably be resolved in favour of the version of Theophrastus.⁷⁷

One critical issue here is whether ἀποκρίνεσθαι or ἐκκρίνεσθαι is the correct verb for how the contraries are generated from the *apeiron*. Kahn's suggestion is that Theophrastus' ἀποκρίνεσθαι is an improvement on Aristotle's ἐκκρίνεσθαι.⁷⁸ He says that:

Theophrastus' superiority as a documentary source is here apparent.⁷⁹

However, later in this book I will argue, along with several modern scholars, that ἐκκρίνεσθαι (understood in a biological sense as 'to be secreted') is a better fit with Anaximander's organic account of *phusis* than the more mechanical ἀποκρίνεσθαι ('to be separated') used by Anaxagoras.⁸⁰ If that is correct, then this significantly undermines any attempt to portray Theophrastus as a superior source. It is possible that Theophrastus sees connections between Anaximander and Anaxagoras so we get the Anaxagorean ἀποκρίνεσθαι here.⁸¹ I treat Aristotle, Theophrastus (and Plato) as having access to an oral tradition, each representing that in their own way with none of them intrinsically more or less reliable than the others.

Methodology

If it is the case that neither Aristotle nor Theophrastus is a fully reliable witness and that neither had sight of the text of Anaximander, there are some important

methodological consequences. First, the attempt to reconstruct the text of Theophrastus on Anaximander by a painstaking analysis of the later doxography, while still interesting and important, is no longer quite so critical to the project of understanding Anaximander. Put bluntly, I do not think the accurate reconstruction of Theophrastus on Anaximander immediately gives us an accurate account. I also think there is a limit to what can be done on the current evidence in reconstructing Theophrastus. Kahn comments on:

The hopelessness of any attempt to reconstruct Theophrastus' original words when they are not cited verbatim by our best sources, Simplicius and Hippolytus.⁸²

A huge amount has been done on this – not least by Kahn – so reconstructing Theophrastus on Anaximander is now rather a dead end. Kahn's *Anaximander and the Origins of Greek Cosmology* is still the key work on Anaximander and a marvellous piece of scholarship, but it is perhaps worth noting how 'Theophrastean' that book is. On the arrangement of the doxography, Kahn comments that:

The following pages contain what is left of Theophrastus' account of the doctrines of Anaximander . . . the order of subjects is in general that of Simplicius or Hippolytus, our two best sources, but the aim has been to reproduce the order of Theophrastus' own work.⁸³

It is also worth noting that Kahn adopts alternatives to Theophrastus being wrong and alternatives to Theophrastus saying something less intelligent.⁸⁴ Kahn believes that Aristotle and Theophrastus had Anaximander's text. I say this not to criticise his approach but merely so that we are aware of some of the historiographical choices that Kahn makes in that book.⁸⁵

Aristotle and Theophrastus on Anaximander

The second methodological consequence is that there is less of an imperative to defend Aristotle and Theophrastus on Anaximander. Engman has commented that:

In view of the extent to which we have to make use of information deriving from Theophrastus himself in identifying and correcting any supposed mistake by him, it would obviously be preferable to avoid an interpretation which hinges on the occurrence of such a mistake.⁸⁶

Fineklberg quotes her approvingly and adds:

To assume an error in Theophrastus would thus be an emergency move, demanding very good reasons indeed to adopt . . . they show he must, not merely might have been wrong.⁸⁷

I am aware of the issues involved in suggesting that Theophrastus may have been wrong, not least the questions of deciding which parts are right/wrong and whether if we deem one part to be wrong we can properly deem any other part to be right. However, as I have a more sceptical attitude to whether Theophrastus had access to Anaximander's texts, I am willing to at least investigate the possibility that Theophrastus may have been wrong and, indeed, that Aristotle before him may also have been wrong. Of course that will put a great onus on the criteria we use here, but I hold that to be a good thing, enhancing our understanding of the reliability of the material, rather than allowing a blanket acceptance of what Aristotle and Theophrastus report.

Allusions

The third methodological consequence is that we might begin to consider the possibility of different approaches to the evidence on Anaximander. Are there earlier sources than Aristotle and Theophrastus? If we are to look at these, one might reasonably ask, what earlier sources? Surely Diels and those who have come after him have hunted down every reference to Anaximander?⁸⁸ Every reference to Anaximander by name, certainly. I wish to suggest that there are two other important sorts of evidence here. First, that philosophers prior to Aristotle alluded to Anaximander's views, without naming him. I believe that there is at least a case to be investigated here in relation to Anaximenes, Heraclitus and Plato.⁸⁹ This may give us important supplementary evidence, even if that evidence may be tricky to handle. Second, that Anaximander himself alluded to the poets without naming them. I believe there is a very strong case for Anaximander alluding to Hesiod and that there is at least a case to be investigated here in relation to Homer, Theognis, Solon and Terpander. If we ask 'why Hesiod?', then I would cite Heraclitus, Fr. 57, 'The instructor of most men is Hesiod'. Again, this may give us important supplementary evidence, even if it may be tricky to handle. It is difficult to define the criteria for what is and is not allusion; even if we find allusion, on its own this is no guarantor of attitude. The alluder may come to praise or to bury the alluded, or have other motives, though I will

suggest that transformation is the dominant motif for Anaximander. I do not believe that either of these types of evidence is unusual within Presocratic philosophy.

I take it as straightforward that Plato alluded to Presocratic thinkers without naming them, often (but not always) making some criticism of them, implicit or otherwise.⁹⁰ I also take it as straightforward that there are passages in Aristotle which do not name Anaximander but do give his views.⁹¹ Did Presocratic philosophers allude to earlier thinkers without naming them? The simplest example here is Empedocles and Parmenides. Parmenides, Fr. 8, 50–52, says that:

At this point I stop my trustworthy account of thought
and truth. From here on learn the opinions of mortals,
listening to the deceitful *kosmos* of my words.

Empedocles seems to allude to this directly when he says:

Listen to the undeceitful passage of my words.⁹²

I believe that Empedocles also makes the same sorts of allusions to Heraclitus' work. Did Presocratic philosophers allude to the poets? The simplest passage here is Xenophanes, Fr. 11:

Homer and Hesiod have ascribed to the gods all those things which are shameful
and reproachful among men: theft, adultery and deceiving each other.⁹³

Did Presocratic philosophers allude to the poets without naming them? Here we can cite Xenophanes, Fr. 1:

Do not speak of Titans or Giants or Centaurs, fictions of old, or furious battles.
In these there is nothing useful.⁹⁴

Are there more subtle ways in which Presocratic philosophers allude to the poets? Xenophanes says that:

What is called Iris is also a cloud, red, purple and greenish yellow to see.⁹⁵

Leshner also makes an interesting point about the closing words of this line.⁹⁶ Homer often finished lines with 'marvellous to see', with the gods being implicated in why this was marvellous. Here Xenophanes finishes his line with the same 'to see' but with simply the colours, no 'marvellous' and nothing about the gods. As Leshner comments, those used to the rhythm and content of Homer would appreciate the difference here with Xenophanes.

I take it then as quite possible for Plato and some of the Presocratics to have alluded to Anaximander without naming him and for Anaximander to have alluded to some of the poets without naming them. There are of course difficulties with this evidence. We might ask whether we know that either Plato or the Presocratics had the text of Anaximander in front of them. With the possible exception of Anaximenes, the answer has to be that we simply do not know. Are Plato and the Presocratics good witnesses? With Plato, there are well known concerns about his depiction of Presocratic thinkers and their views. Plato was not and did not profess to be a historian of philosophy; when he reports or alludes to the views of earlier thinkers there is usually a strong polemical context. It may be that Plato in places exaggerates the views of his predecessors for philosophical, dramatic or humorous effect.⁹⁷ With the Presocratics, we simply do not have enough information to tell whether their representations of earlier thinkers are accurate or what sort of agenda they may have had in making references or allusions. There is also a difficulty with some candidate evidence for allusion. In order to identify allusions, we must make suppositions about Anaximander's views. The supposed allusion cannot verify those views as there is a circularity involved here. Some candidate allusions may be reasonably clear; others may suffer from this problem. There are similar problems with the relation of Anaximander and the poets. Some allusions may be reasonably clear while other candidates require assumptions either about Anaximander or the poet.

While this approach is to some extent inspired and influenced by Burkert's new approach to Pythagoras (that we should look to the earlier sources of Plato and Aristotle rather than later sources) there are also some significant differences.⁹⁸ Burkert generally deals with passages which name rather than allude to Pythagoras, though the distinction is not entirely clear. I do not privilege the material earlier than Aristotle in any way. As I hope is clear from what I have said above, we should apply the same criteria. I merely say that this sort of evidence may exist, we should certainly look to see if it does exist and, where it does, we should scrutinise it in the same way as we do the evidence in Aristotle and Theophrastus.

Although I have discussed the oral transmission view and the allusions approach together, they are of course independent. One does not have to accept that Aristotle and Theophrastus did not have sight of Anaximander's texts in order to believe that there may be interesting evidence of Anaximander alluding to poets or later thinkers alluding to Anaximander, nor does one have to accept the evidence on allusion in order to be sceptical on Aristotle and Theophrastus.

Likenesses and choices

One thing this book will emphasise is that we have choices to make in interpreting the evidence on Anaximander. Sometimes strategies for making those choices remain tacit. Here I want to be explicit about some of the choices made in the literature and which this book makes. Jaeger once commented that religious belief is:

An aspect which has been unduly neglected or minimised by scholars of the positivist school because in the early Greek philosophy of nature they saw their own likeness.⁹⁹

As discussed earlier, modern historiography leads us away from this bifurcation of science and religion but Jaeger's comment is a useful starting point for the issue of whether we see something we like in Anaximander and marginalise other aspects of his thought. This can also be put in a different way, as von Staden has done, in terms of 'affinities' and 'elisions'.¹⁰⁰ Do we seek affinities between modern ideas and aspects of Anaximander's work and pass over other ideas? There is a counterpart to this too, which is whether some commentators, seeking to minimise the differences between Anaximander and Hesiod or Anaximander and other predecessors, seek affinities between ancient ideas and aspects of Anaximander's work and pass over other ideas.

I think Jaeger's remark is a fair comment on at least some of the positivists. It is also important to generalise Jaeger's line of thought here. So:

Are there aspects of Anaximander's thought which have been neglected or minimised, or alternatively have been over-emphasised by commentators, whatever their views on the history and the philosophy of science, because in Anaximander's account of nature they saw a likeness between Anaximander and what they think is important in modern science?¹⁰¹

That will be an important question in relation to many aspects of Anaximander's thought, not least in his account of the origin of animals (a precursor of evolution?), his account of the *cosmos* (multiple worlds?) and his account of the origin and function of the *cosmos* (mechanical?). One reason why I raise these issues is that this book will put forward a couple of radical new ideas on Anaximander. I cannot demonstrate, beyond reasonable doubt, that these ideas are correct, although I do think they are both interesting and tenable hypotheses. Why do I like these ideas? On what criteria do I think these are interesting or useful hypotheses? How can they be argued for relative to other interpretations

of Anaximander? I have framed the discussion in this way because some of the interpretations I will suggest lead away from direct affinities with modern science. This, in more general form, will be an important line of investigation for this book. I will not be trying to play up the affinities with modern science, or the technical sophistication of Anaximander's specific theories. Rather, I just want to see what is plausible given the evidence we have and the context for those theories. What I do want to examine, as thoroughly as I can, are the principles behind Anaximander's theories, if any can be discerned. Are they coherent? Do they have some epistemic merit? To return to the issue of theory quality, even if the individual theories may be problematic, there may be considerable merit in the principles by which those theories are put together. One theme in what follows is that if we push too hard to make Anaximander modern or sophisticated in his specific theories we run the risk of losing sight of the quality of the principle behind those theories.

Style

A note on the style of this book. There are relatively few fragments for Anaximander and the meaning of those we have is far from clear. Some fragments have very broad implications, both for Anaximander's thought and how we approach other Anaximander fragments. This makes it difficult, and even in my view unwise, to attempt to write a entirely 'linear' narrative on Anaximander, whereby one produces an exhaustive analysis of one fragment, comes to a definitive conclusion and then moves on to the next fragment. Sometimes it will be necessary to return to a fragment or theme to examine a different aspect or to look at its implications in a different context. The aim, ultimately, is to produce a coherent network of how the Anaximander evidence fits together. On the choice of chapter titles, I am trying to show that Anaximander dealt with the topics associated with the Presocratic investigation of nature, whether or not he used the term *phusis*. On the order of the chapters, I begin with zoogony and meteorology as I believe I have some important new things to say on these topics which are thematic for the rest of the book. The rest of the chapter order is more conventional, moving through a philosophical/temporal development from the nature of the *apeiron* to cosmogony to cosmology to astronomy.

Anaximander's Zoogony

It is generally recognised that Anaximander made the first surviving attempt at a natural explanation of the origins of life. In this chapter I want to start by looking in detail at one of the reports of Anaximander's zoogony, Pseudo-Plutarch, V, 19, 4,¹ which has the first animals born in moisture, shedding their bark-like enclosures, moving to somewhere drier and then living in a different form for a short time. One of the problems with this passage is that, as commonly translated, the process described has no referent in nature. This has resulted in either bizarre speculation as to what sort of creature Anaximander might have had in mind,² or criticism that what is reported here is no more than a 'genial fantasy'.³ Here, I argue that there is a sound alternative translation which has the advantage that Anaximander's account would then appear to be based on the life cycle of an existing type of insect, the Caddis fly of the order Trichoptera. If so, his account of zoogony is neither outright speculation, nor a piece of arbitrary philosophising, as has been suggested in the literature, but it is based, however loosely, on observational knowledge.

This hypothesis has some further important consequences. First, it has been widely supposed that when Anaximander spoke of life originating in water, he meant sea water rather than fresh water.⁴ However, if he did mean fresh water this opens up some intriguing new possibilities. Second, Caddis flies move 'to the drier' and undergo metamorphosis as part of their life cycle. There is no need to suppose the first creatures were amphibians, or that some climate change (often the supposed drying up of the earth) drove them to adapt to life on land. Metamorphosis as a natural and ongoing process may also have been important for Anaximander in explaining how more complex life forms have simpler roots. If there are parallels to be drawn between Anaximander's zoogony and his cosmogony, a process parallel to metamorphosis may be significant in his cosmogony. We may then need to re-assess the nature of Anaximander's zoogony and its relation to his cosmogony and cosmology. One interesting line of thought here is that Anaximander was a uniformitarian in both cosmogony and zoogony.

Third, there has been some debate as to whether or not Anaximander was an evolutionist. I argue that while he did envisage the development of new species, he was very far from any modern notion of evolution. There is no role for chance, there is no sense of survival of the fittest, nor, if the Caddis fly hypothesis is correct, is there adaptation to the environment. I raise the possibility here that some form of intelligent design, or idea of organic growth, based on the steering ability of the *apeiron* may fit Anaximander's thought rather better.

Anaximander's zoogony

Pseudo-Plutarch, V, 19, 4 gives the following account of Anaximander's zoogony:⁵

Ἄναξιμανδρος ἐν ὑγρῷ γεννησθῆναι τὰ πρῶτα ζῶα φλοιοῖς περιεχόμενα ἀκανθώδεσι, προβαίνουσας δὲ τῆς ἡλικίας ἀποβαίνειν ἐπὶ τὸ ζηρότερον καὶ περιρρηγνυμένου τοῦ φλοιοῦ ἐπ' ὀλίγον χρόνον μεταβῶναι.

Anaximander said that the first living creatures were born in moisture enclosed in thorny bark; and that as their age increased they came forth on to the drier part and, when the bark had broken off, they lived a different kind of life for a short time.⁶

This is the Kirk, Raven and Schofield translation, which is perfectly reasonable and represents an orthodox way of translating this passage. There are no textual issues here. It is universally taken to be authentic in reporting Anaximander's views.⁷ Several words here can be found in other Anaximander fragments and the passage sits well with the other zoogony fragments while having an interesting relationship to the cosmogony fragments. I would translate:

Anaximander, the primary animals were generated in moisture enclosed in spine like barks, as they advanced in age they moved onto the drier⁸ and shedding their bark for a short time they survived in a different form.

It is important to note that περιεχόμενα can also have a sense of defending, protecting or guarding, all of which are relevant here. I take περιρρηγνυμένου as having a middle sense, thus taking the connotations of shedding a covering for oneself rather than having it broken. LSJ give '*break off all round: freq. of clothes, rend and tear off*' and under middle usages '*tore off her own garments*'. Aristotle uses περιρρήγνυμι at *Historia Animalium* 551a23 for a butterfly breaking out of a chrysalis, at 552a9 for gnats breaking out of their sheaths, at 552a9 for all animals which break out of larvae, and at 554a30 for bee larvae

breaking out of their membranes. Conche has 'quand leur écorce se fut brisée' and Wöhrle has 'nachdem die Rinde ringsum zerborsten sei'.⁹ The point of translating in this manner is that way we then have a referent in nature: the Caddis fly.

Caddis flies

There would have been many species of Caddis fly living in Greece in Anaximander's time; they are still widespread throughout Europe today, with around 220 species in mainland Greece. These flies begin their life as eggs in freshwater, before becoming larvae. These larvae then construct a case for themselves out of small twigs, bark, vegetation, mollusc shell, gravel or sand, depending on their species and environment. The cases are typically 25mm long and 5mm in diameter and are cemented together with a secretion from the larvae. Again, depending on species and environment, these cases can be fairly smooth or quite rough in texture. They can be tubular, spiral or square and they can be straight or curved along their length. They are usually, but not always, closed at one end and they serve as both camouflage and physical protection. The larvae next pupate, usually attaching the case to the underside of a stone, and sealing up both ends. The pupae then break out of the cases, swim to the surface, shed their skin and fly off. They live for several months in the water and, while there is some variation, they live on average between one and two weeks. Caddis fly cases can look like this:¹⁰

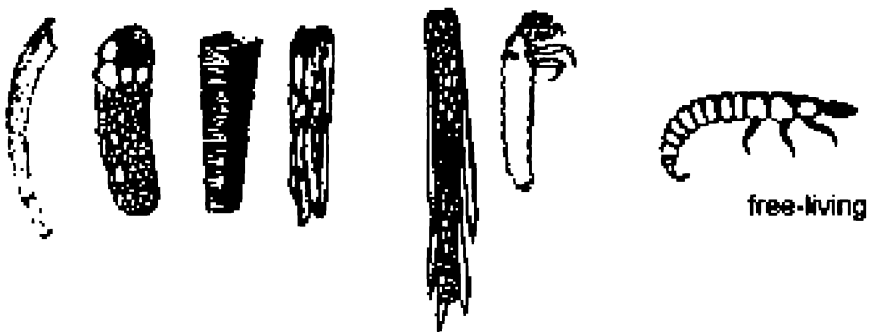


Figure 2.1

Caddis flies are not difficult to observe in their cases. Typically many of them will group together on a submerged stone or log and are readily visible. Their existence is common knowledge among modern freshwater fisherman.

Anaximander and Caddis flies

The life cycle of the Caddis fly is not absolutely identical to that described by Anaximander, but is reasonably close given what was likely to have been known at the time. Caddis flies are not, of course, generated spontaneously from moisture, though it is quite possible Anaximander believed that. Certainly Aristotle believed that the larvae of many flying insects were produced spontaneously.¹¹ Possibilities for observing supposed spontaneous generation were widespread in the ancient world, the instance most usually cited being the proliferation of flies arising from the drying mud of the Nile after flooding.¹² The young larvae do enclose themselves in cases, in fact may do this several times, shedding their cases as they grow too large for it and constructing a new one. Caddis flies do not 'move onto the drier' in the sense of moving onto dry land, but they are often found attached underneath stones or logs; that may be sufficient for them to be described as 'moving to the drier.' They do break out of the case themselves.

Caddis larvae undergo metamorphosis and so survive in a different form. Their life as adults is significantly shorter than their life pre-metamorphosis, so they do survive in a different form for a short time. Anaximander probably only knew that they survived as adults for a relatively short time. There are many other species of fly living in and around rivers which have a very short life as adults, sometimes as short as one day. The short survival time of the new creatures has puzzled many commentators. Loenen comments that:

We know that the conditions of life of the first land-animals must have been unnatural (e.g. imagine a lion enveloped by a prickly bark), and therefore a fairly sudden and fundamental change in their way of living must have taken place. On the other hand, we can see no reason why the animals should have 'survived only a short time'.¹³

The Caddis fly hypothesis restricts this passage solely to the life cycle of the Caddis fly and the short life after metamorphosis is a perfectly natural consequence.

It is at least a reasonable hypothesis, then, that Anaximander had the Caddis fly in mind in this passage. They would have been widespread in ancient Greece. The cases they create are fairly obvious to anyone who turns over a few stones or logs in a stream at the right time of year, so their existence and behaviour may well have been common knowledge.¹⁴

Translation again

There are two further issues of translation/meaning here.¹⁵ Most translators render φλοιοῖς . . . ἀκανθώδεσι as 'thorny' or 'prickly bark'. Is that a reasonable description of Caddis fly cases?

The definition Liddle, Scott and Jones (LSJ) give for φλοιοῖς is 'A. *bark* of trees, esp. *smooth bark* (such as one can cut one's name on)'. When Aristotle speaks of the young of snakes, he says that, they have 'no shell like φλοιοῖς surrounding', which again would suggest something smooth.¹⁶ Alternatively, Anaximander may simply mean 'bark' as in a tree, which would allow for some roughness.

LSJ give 'any thorny or prickly plant' as the primary meaning of ἀκανθα, but it can also mean the backbone of animals or men (Herodotus, 4.72.5, Euripides, *Electra*, 492) or the spines of a hedgehog. I translate 'spine like' so as to leave the options open here.

Cornford translates φλοιοῖς . . . ἀκανθώδεσι as 'prickly bark' and suggests the first animals were 'like sea-urchins',¹⁷ but this is rather a dead end as sea-urchins do not move onto the drier or undergo any interesting transformations. Clearly a critical question is how appropriate ἀκανθώδης is as a description of the Caddis fly case. I suggest four possibilities here:

- (a) We can give ἀκανθώδης the usual sense of prickly or thorny, but understand this as rough or uneven. The cases of some types of Caddis fly are quite rough and uneven, but not prickly.
- (b) We can translate ἀκανθώδης as 'backbone like', as the cases are long, hollow and slightly curved. However, there would then be the question of the relation of ribs to the spine.
- (c) We can translate ἀκανθώδης as 'spine shaped' with the spines of a hedgehog in mind, with the sense that the case is long, thin, hollow, slightly curved and closed at one end.

- (d) We can translate ἀκανθώδης as ‘thorny’, but with the sense that the cases are constructed from long thin shards of bark, which is correct for some Caddis flies, and take it that this says nothing about the overall shape of the cases.

All of these possibilities fit well with φλοιοῖς taken to mean a degree of roughness similar to tree bark. On the question of what ἀκανθώδης describes, I am inclined to think it either refers to the overall shape of the case (long, circular, slightly curved, hollow, closed at one end like a hedgehog spine) or that it refers to the shape of the pieces of bark the case is constructed from.¹⁸

This is the only occurrence we are aware of for μεταβιώναι, so LSJ are understandably brief in giving only ‘live after, survive.’¹⁹ However, Kahn discusses the word and says that:

A verbal compound in meta – normally indicates a change from one condition to another, and μεταβιώναι should mean ‘to live a different life’ or ‘to survive in a different form.’ Either sense is applicable to Anaximander’s view.²⁰

While I agree with Kahn’s philology, the senses he gives can be interpreted in radically different ways:

- (a) If our creature emerges ‘to live a different life,’ this might be essentially the same form of the creature now living on the land rather than in the water, or simply living an adult life rather than being a juvenile in its bark. Diels gives ‘*mutare vitam*’. LSJ give ‘*change one’s way of life*’ for μεταδιατάω.
- (b) If our creature emerges ‘to survive in a different form’ this may be a creature which has undergone metamorphosis and now has a very different form to when it was in its bark.

Conche renders this ‘ils modifièrent leur genre de vie peu en temps’; Wöhrle has ‘für kurze Zeit auf andere Weise gelebt’; and Mansfeld has ‘auf kurze Zeit eine andere Lebensweise durchgehalten.’²¹ I opt for the second alternative here. With the translation re-worked in this manner, we now have a good match between Anaximander’s description and the life cycle of the Caddis fly.

The evolution debate

There has been considerable debate concerning Anaximander and evolution.²² It is rare nowadays to find anyone to support the view that Anaximander was a Darwinist or in some way anticipated all the important parts of Darwinian

evolution, but some of the older literature did take this view.²³ We can find Gomperz saying that Anaximander was:

'Der erste Darwinist'²⁴

Eastman also put this in a forthright fashion:

In so far as the theory of evolution is concerned, history shows beyond all doubt that it took its rise among Ionian philosophers, declined with the decay of Greek science, was kept alive by Greek influence in theology, and, after gathering increased momentum, became revealed in fuller grandeur to Lamarck and Darwin.²⁵

So too Burnet says that:

It is sure that Anaximander had an idea of what is meant by adaptation to environment and survival of the fittest and that he saw the higher mammals could not represent the original type of animal.²⁶

The evidence for adaptation to environment is the passage we have just looked at, taken in conjunction with the idea that, for Anaximander, the world is at the moment drying up.²⁷ So as the earth dries, the animals referred to in our passage are forced 'onto the drier' and have to adapt to the changing environment. My answer to this is simple. There is no adaptation to environment here, merely the normal execution of the life cycle of the Caddis fly.

There is also no need to attempt to tie Anaximander's zoogony with his theory that the earth is becoming drier.²⁸ The first life forms in their cases are not forced to migrate onto the drier by changing climatic conditions, but do so naturally as part of their life cycle. Moving to dry land is not then an adaptation to a changing environment as Burnet²⁹ and Kahn³⁰ have suggested. Nor need we take it with Barnes³¹ that the first life forms were amphibians. A further consideration here is that it is the sea that is said to be currently drying up, not the freshwater sources relevant to Caddis flies. I also take the view that the drying up is not a terminal affliction of the earth, though neither is it simply part of a cycle. It is quite possible that the earth at an early stage was more moist than it is now, but when a sufficient amount evaporated off, a stable weather cycle of evaporation/rainfall is established. The evidence for the drying out of the earth in Anaximander comes from Alexander's commentary on this passage from Aristotle, *Meteorology*, II/1, 353b6 ff.:

At first the whole area surrounding the earth is moist, but due to the drying of the sun, that which is evaporated makes winds and the turnings of the sun and moon, they say, while that which remains is the sea. Thus they think it is becoming less through being dried up, and will at some point end up being entirely dry.

Alexander, *Meteorology*, 67, 11 says:

Of this view were Anaximander and Diogenes, according to the history of Theophrastus.

I will come back to these passages in greater detail in a later chapter as there are important issues here about how Anaximander understood natural processes, the ultimate fate of the earth and the *cosmos*.

In my view we must differentiate Anaximander quite sharply from modern theories of evolution. There is nothing in Anaximander to suggest adaptation to the environment. There is nothing to suggest survival of the fittest. There is nothing to suggest natural selection. A critical point, which we will look at in considerably more detail when we look at cosmogony, is that Anaximander does not rely on chance in any way. We have no evidence that he invoked chance either in his cosmogony or his zoogony and have good reason to believe that he did not. This places him in very sharp contrast with Empedocles. There is no sense in what little we have of Anaximander that this might happen differently in different places as in the early atomists. This also differentiates Anaximander very sharply from modern notions of chance adaptations.

There is an interesting tacit assumption among those who attribute evolution to Anaximander, which is that Anaximander, in each of the relevant passages, is talking about salt water.³² So Loenen comments that:

We now have to face the problem how to understand this strange theory, according to which all organic life originated in the sea.³³

Perhaps that is influenced by the modern theory of evolution because Anaximander appears to be talking about a saltwater fish in one fragment. If the Caddis fly hypothesis is correct though, it very firmly locates this fragment in fresh water; this may give us a rather different perspective on Anaximander on zoogony as a whole. The Caddis fly hypothesis also frees us from questions like this:

What precisely are these *ta prôta zoa*? Are they the first specimens of each species of land-animals still existing at present, or are they the first specimens of a few first species of animals, from which later the other species came forth (cp. The polyphyletic form of modern evolutionism), or, thirdly, are they the first specimens of one first species (cp. the monophyletic form of evolutionism)?³⁴

In what follows I will suggest that Anaximander's view was polyphyletic, at least in the sense that there was more than one original species but that his view has very little to do with what we understand by evolution.

Metamorphosis

Hippolytus, *Refutation of All Heresies*, I, 6, 6–7 tells us that for Anaximander:

Living things were generated from moisture being evaporated by the sun. In the beginning, man was similar to another life form, namely fish.

So Anaximander has man as a descendant of fish. It is important here to distinguish between a theory of development and a theory of evolution. Clearly Anaximander has some sense of the development of life on earth but whether that ought to be thought of as a theory of evolution is another matter. There is, then, a question of how there can be the transformation of fish to men. One might also wonder how Caddis flies produce fish and ultimately man. That Caddis flies are the 'primary' animals does not preclude fish being generated independently from moisture as well, especially if the generation of animals from moisture is a relatively common and ongoing process. There is a final translation issue with our main passage. This passage tells us about *ta prôta zoa*, usually translated as 'the first animals', almost always taken in the sense of 'chronologically the first animals'. That certainly is a strong possibility, but I have translated 'primary animals' rather than 'first animals' as there are some other possibilities worth considering. Conche has 'Les premiers animaux' while Wöhrle has 'die ersten Lebewesen'.³⁵ These animals may be primary in the sense of being the simplest or most basic creatures. It is also possible that these animals may be primary in the sense that they are at the bottom of the food chain. Why are the Caddis flies 'primary'? Perhaps because Anaximander recognised that fish feed on Caddis flies and 'would not have long survived', as the Pseudo-Plutarch passage puts it (see below), without a viable food supply. I would note here that this passage very much favours freshwater generation of life rather than saltwater generation. The mixture of earth and water which is heated is something which is quite straightforward in streams and rivers, especially those which run lower in summer and so expose some of their bed to the sun. It is possible that brackish rather than fully saltwater generation is meant here (estuaries with lots of silt in the water, or perhaps tidal mud flats), but the balance is with freshwater generation.

What I want to suggest here in relation to the development of life on earth is that metamorphosis gives Anaximander a model for change. With the Caddis fly passage, a simple life form is changed into a more complex life form by the process of metamorphosis, in a radical, rapid and natural change that we can still observe. I have been careful here to phrase this in as neutral terms as possible. In modern biology, we do not think of metamorphosis as resulting in speciation, the

generation of a new species. This is the same species merely undergoing a radical transformation as part of its life cycle. One might suggest though that for Anaximander the metamorphosis of the Caddis fly does result in new animals and can be used as a model for new animals in other situations. I am being careful here not to attribute the modern notions of species or speciation to Anaximander, or indeed any notions of species or speciation. All Anaximander needs for his account are means by which more complex life forms can be generated from simpler life forms and that ultimately simpler life forms can be spontaneously generated.

I take the Caddis fly to be a more complex organism than the Caddis grub in the same sense that a common housefly is more complex than a maggot, the maggot undergoing metamorphosis as a chrysalis. One can argue that in modern terms (a fly has a much greater diversity of body parts, wings, legs, etc.) though perhaps more important would be whether in the context of ancient Greece Anaximander and others would take a fly to be a more complex organism. On that issue I would give a stronger yes, on the basis that a modern answer is based largely on function, an ancient answer would be likely to include an aesthetic component as well.

It is likely that Anaximander thought that Caddis flies, or more precisely their larvae, were generated by the action of the sun on moisture, as in our first passage here, as well as fish. Do we have one instance of generation for Anaximander or many? Are fish part of the same chain as Caddis flies? I would suggest that we have an independent origin for fish here, rather than a development from Caddis flies. It is quite possible he thought that several different types of primitive organisms could be spontaneously generated. Two considerations on the spontaneous generation of fish. First, Aristotle believed that eels were generated by spontaneous generation. Second, leave a large container of water outside during the summer. You can put some organic matter in yourself to help the process along, though left to itself the container will soon acquire some organic detritus such as leaves or mould, etc. In a few weeks you will find that there are some small creatures in your water, propelling themselves with their tails, which might be mistaken for primitive fish. Place yourself in the context of the ancient world and you might well believe that you have just seen the spontaneous generation of the simplest fish.

Other zoogony passages

There are three other passages concerning Anaximander and the origins of life. Pseudo-Plutarch, *Stromateis*, 2 = DK12A10 tells us that:

In the beginning, he says, man was generated from other life forms. Others are swiftly able to sustain themselves, man alone being in need of nursing for a long time. Because of this, he would not have long survived if this had been the original form.

Censorinus, *De Die Nat*, 4, 7, DK12A30 gives a little more detail:

Anaximander the Milesian believed that out of water and earth that had been heated arose fish, or animals very similar to fish. In these men were formed and as embryos kept within until puberty. Finally these things ruptured, and humans who were already capable of nourishing themselves came out.

Pseudo-Plutarch gives us the very interesting consideration that human beings must have been generated from other life forms as human young are unable to fend for themselves for such a long time. The Censorinus passage gives us fish-like creatures being generated from heated earth and water, and we have seen the plausibility of the spontaneous generation of fish-like creatures above. On the Censorinus passage, Kahn comments that:

The words *ruptis illis* refer grammatically to *pisces seu piscibus simillima animalia*, but in fact it must be the wrappings of the early sea creatures which are meant.³⁶

Grammatically I agree, but I do not see any problem which means we must suppose 'the wrappings of the early sea creatures' are actually meant here. It need not be the fish which rupture, but some form of supposed amniotic sack in which the embryo developed. It is also possible that it is the fish which rupture, if we are talking of fully grown humans within fish of a size which could not give birth to them. That humans in some way emerged from fish might also indicate freshwater generation. Otherwise, the newly emerged humans would face a significant swim to land. The mention of puberty may also be significant here, as the newly emerged humans would be able to reproduce amongst themselves.

How do we get humans from fish? The key word here may be *ruptis*, from *rumpo*, which can take the sense of to burst or to split. If the humans are 'kept within' as they grow, we can hypothesise that they are kept in some form of protective membrane which eventually splits. This would seem to give us the same sort of scenario as the Caddis larvae, which then undergo metamorphosis to become Caddis flies. Technically, there may of course be many objections to transferring the modern idea of metamorphosis to fish. That is not what I am suggesting here though. Rather, metamorphosis as Anaximander sees it in the Caddis fly may be a model for how more complex creatures can be generated from less complex creatures. That model is then transferred to fish for the

generation of human beings. In relation to this idea of fish being part of the ancestry of humans, there is an interesting passage at Aristotle, *Historia Animalium*, V/1, 539a16–25:

There is a property which animals have in common with plants. Some plants are generated from the seed of plants, while others are self-generated through the formation of some principle similar to a seed. Of these latter plants some get their nutrition from the earth, while others grow inside other plants, as is stated in my work *On Plants*. Now concerning animals, some are generated from parent animals according to their kind, but others grow spontaneously, not from kindred stock. Concerning these instances of spontaneous generation, some come from putrefying earth or vegetable matter, which is the case with many insects. Others are spontaneously generated inside animals from the secretions of their organs.

If the last sentence or two here represents a common view in ancient Greece, Anaximander may have thought that humans were initially generated inside fish before undergoing metamorphosis. It is also worth noting that humans are kept inside until puberty so that they are immediately capable of breeding and that Caddis flies are also capable of immediate reproduction. Does Anaximander suppose that the flies are capable of mating with one another and producing offspring? Does this happen alongside what appears to be a repeated original generation of flies? Is the early life of the flies' offspring similar or quite different from those generated from moisture in spine-like barks? If there was a significant disparity between the number of cases found and the number of flies observed, as would be very likely, a reasonable conclusion would be that while some flies are generated *ab initio* each year, the adult flies have another method of reproduction. It is interesting to note here that Aristotle certainly thinks that some species can be generated spontaneously and reproduce sexually.³⁷ Plutarch, *Symp*, VIII, 730e, DK12A30 gives us some more on the fish and human relationship:

The Greeks of old sacrificed to Poseidon as the first father, believing that humans grew from a moist substance, as the Syrians did. So the Syrians revere the fish as it is of a similar type and nurturing. They reason more plausibly than Anaximander, who does not class fish and men together, but believes that men were generated and nurtured in fish, like the shark, and when they had become capable of fending for themselves, they then they stepped out and took to the land.

The fish referred to here, *galeus levis*, does give birth to live young even though it is not a mammal. The young are born from eggs within the female. The young

then mature within the female before being 'born'. This was well known in the ancient world.

Kahn has cast doubt on this Plutarch passage. One issue here is whether humans were born from fish, as in the Censorinus passage, or were generated and then nurtured within fish; another is whether this passage contradicts our initial Caddis fly passage from Aetius. The context of Plutarch's passage is significant here. It is part of a discussion of why the Pythagoreans rejected eating fish and it may well be that Plutarch embellishes his knowledge of something Anaximander said in order to provoke a good discussion.³⁸ While I agree with Kahn that we need to be cautious with this passage given its context, I don't see anything in the Plutarch passage which contradicts the Aetius passage as I construe it. On my view, Caddis flies are generated first, then fish, in separate acts of spontaneous generation. So what happens in the generation of humans from fish is not really relevant to the Aetius passage and I take the use of cases to be specific to Caddis flies rather than general to all forms of initial generation.³⁹ One piece of speculation which may help to tie these five fragments together is that some of the fish which eat adult Caddis flies are migratory, that is, for part of the year they live in the sea but they come into freshwater streams to reproduce. The sea trout is a good example of this sort of behaviour. If fish had their origins in fresh water, this would give Anaximander the link to saltwater fish.

Zoogony and cosmogony

It is common for commentators to draw tight parallels between Anaximander's cosmogony and his zoogony.⁴⁰ The important cosmogony passage here is Pseudo-Plutarch, *Stromateis*, 2:

He (Anaximander) says that which is productive out of the eternal hot and cold was separated at the genesis of this cosmos, and that a sphere of flame was formed around the air around the earth like the bark around a tree. When this was broken off and enclosed in certain circles, the sun, moon and stars were formed.

This passage follows on from a Pseudo-Plutarch passage we have already looked at, which begins: 'In the beginning, he says, man was generated from other life forms.' It is clear that there are some interesting relations between Anaximander's cosmogony and zoogony. Here we have a sphere of flame around the earth 'like the bark around a tree'. We have the same word for bark here as we did in our first

passage on zoogony, *phloios*. This bark is broken off as part of the cosmogonic process. The cosmogony appears to give us a slightly more physical take on generation, the zoogony a slightly more biological one, especially how I have translated it with the emphasis on what the Caddis larvae do for themselves. The interesting strategic question is, then, if we are going to draw parallels here, is whether we see both as physical models or both as biological models. There is an interesting alternative to this pair of strategies, which is to acknowledge that there are important similarities, but allow that there may be some subtle and interesting differences for Anaximander between the genesis of the earth and the genesis of living things. Kirk, Raven and Schofield (KRS) take the first option here, emphasising the physical aspects of both processes.⁴¹ In relation to the Caddis fly passage, KRS say that:

The use of *φλοιοῖς* here reminds one of the bark-simile in the cosmogonical account; both ball of flame and prickly shell broke away from round the core (here *περι-* not *ἀπορρήγνυσθαι*).⁴²

This is why KRS have the barks being expanded and then split by heating.

Moreover the general principles of the development of birth are similar: moisture is contained in a bark-like covering, and heat somehow causes an expansion or explosion of the husk and the release of the completed form within.⁴³

This is a perfectly reasonable strategy, as long as we recognise that it is one possible strategy among many. We hold the more physical account of cosmogony as central and interpret the zoogony with that in mind. So moisture is enclosed in bark-like covering and it is a physical process of heating that eventually breaks that covering. The alternative here is to emphasise the biological aspects of the generation of the earth.

As the texts stand, we do have different verbs for what happens to the *cosmos* and to the first animals. I do not wish to deny that early cosmogonies were often modelled on biological processes. It is a perennial problem in cosmogony to be able to say what cosmogony was *like*. With limited options available, it was perfectly reasonable for early thinkers to think of the origins of a complex, self-sustaining, self-moving *cosmos* in biological terms. Nor do I wish to deny that Anaximander was influenced by biological processes in his cosmogony. What I would question though is the extent to which he envisaged the processes of zoogony and cosmogony as being identical. There is, of course, a question with both these testimonia of how far they reproduce Anaximander's own words, even if they represent his thoughts reasonably well. Dealing with what we have

though, we have ἀπορραγείσης, meaning 'to be broken off or severed from' and περιρρηγνυμένου, which I have taken to mean 'shedding for themselves'. We might also compare περιεχόμενα, with περιφυῆναι, 'to have formed around'. While the first living creatures create their own cases, the earth has its sphere of flame formed for it. Perhaps we should give Anaximander some greater credit here in differentiating between what passively happens to the *cosmos* and what living things are capable of doing for themselves.

There is another important parallel here though, which may give a new perspective on how the earth forms for Anaximander. I have argued above that a key process for Anaximander in the generation of life is a model for change based on metamorphosis. With the earth we have matter in a relatively simple arrangement, enclosed in a bark-like shell, which will end with a more complex arrangement of matter, the earth. Is the change here envisaged as a form of metamorphosis by Anaximander, or modelled on the idea of metamorphosis? That is an intriguing possibility and would give Anaximander more of an account of how the earth forms.

Steering?

One question we might raise is how it is that life begins in moisture and how metamorphosis takes place. There is no reference to any chance occurrence in Anaximander. There is also no independently existing god to intervene to begin life or direct the course of its development.⁴⁴ However, there is another possibility which is that there is some organising principle associated with the *apeiron* which guides the formation of the *cosmos* and of animals. The key phrase here is Aristotle, *Physics*, III/4, 203b7 ff., where he says that Anaximander's *apeiron*:

Surrounds all and steers all.⁴⁵

That it surrounds all and steers all would suggest that it has a considerable influence on Anaximander's *cosmos*. Anaximander would not be alone among the Presocratics in having some form of steering principle. These can arguably be found in Thales, Anaximenes, Heraclitus, Parmenides, the Hippocratic corpus and Diogenes of Apollonia.⁴⁶ If there is this steering effect, how strong is it and to what extent does it govern what happens in the *cosmos*? Kirk's view is that:

We cannot suppose that the Boundless as such interpenetrates the differentiated world.⁴⁷

Even if we suppose this though, it does not mean that the *apeiron* has no influence whatsoever within the differentiated world. Kirk suggests that:

How does the Boundless 'govern' or 'steer' all things? By virtue, obviously, of surrounding or containing them; but what actual control can it exercise within the cosmos, if the idea of innumerable destructions and re-creations is rejected? The question is difficult to answer on any hypothesis.⁴⁸

So too Vlastos comments that:

Thus the Boundless 'governs' the world throughout its growth and decline. This is never a matter of direct action by the Boundless upon the inner structure of the world, for the whole of the cosmology is delineated in terms of the interaction of the opposites themselves upon one another. The Boundless 'governs' by 'encompassing', i.e., by safeguarding the original equality of the opposites with one another.⁴⁹

Throughout the modern literature on Anaximander, there is a tendency either to ignore this steering or to minimise its effect. However, I think there is some interesting ancient evidence which suggests that if there is a steering principle, it can have a thoroughgoing and fundamental effect on all parts of the *cosmos*. Certainly the idea that steering is relevant to the ongoing processes of the world about us is seen in several Greek thinkers. Diogenes of Apollonia, Fr. 5 reads:

That which has intelligence is called air by men, and all men are steered by this and it has a power over all things (καὶ ὑπὸ τούτου πάντας καὶ κυβερνᾶσθαι καὶ πάντων κρατεῖν). This seems to be a God to me and to have permeated everywhere (καὶ ἐπὶ πᾶν ἀφίχθαι), to arrange (διατιθέναι) all things and to be in all things.

So that which steers has the power to arrange all things, and so might be thought to be instrumental in cosmogony and zoogony. Critical here are the ideas that 'all men are steered by this' and that the steering has 'permeated everywhere'. Admittedly, for Diogenes the key substance is air, but there is no reason why Anaximander's *apeiron* could not perform this function. In the absence of other forms of explanation, this would explain why the *cosmos* and animals come to be in Anaximander.

Plato, in the myth section of the *Politicus*, has the *cosmos* controlled by a god who he refers to as 'the helmsman (*kubernêtês*) of the universe' (*Politicus*, 272e3–4). Slightly later we are told that:

When the world nurtures within itself living things under the guidance of the helmsman, it produces little evil and much good.⁵⁰

Aristotle too has something to say about how the heavens steer what is happening in the terrestrial realm, in *Meteorology*, I/2:

The entire terrestrial realm is composed of these bodies [earth, water, air, fire], and as we have said it is the processes which affect them that concern us here. This realm is of necessity contiguous with the upper motions, which means that all of the motions here are steered (*kubernasthia*) by the upper motions. As the source of all motion, the upper motions must be accounted as the primary cause. These are eternal, unlimited with respect to place but are always complete. In distinction, all of the other bodies comprise separate regions from each other. The result of this is that fire, earth and their kindred must be accounted as the material reason for coming to be, while the ultimate reason for their motion is the motive ability of the eternally moving things.

So for Aristotle, the 'steering' effect of the heavens ultimately permeates everything that is going on in the terrestrial realm. I would hold it as at least a strong and important possibility then that steering is involved in the generation of animals for Anaximander. All three of these schemes would give us something stronger than is suggested by Kirk, who comments that:

By enclosing the world, the Boundless prevents the expansion of differentiated matter; if there is thought to be any loss (which is doubtful), the Boundless would make it good. Possibly, if Anaximander thought of the Boundless as divine, he automatically gave it control, without determining precisely how this control was to take effect.⁵¹

I have two comments on this as it is phrased. Firstly, if all the *apeiron* does is surround and prevent the expansion of the differentiated matter, why do we also get told that it steers? That it surrounds would be enough here. Similarly, if the *apeiron* is divine on the grounds that it is immortal and indestructible (see below), why describe it as able to steer as well unless that steering amounts to something significant?

There are two broad interpretations of what this steering might consist of. First, this might be something like what is now known as intelligent design. The best evidence for this is something which Plato says in the *Philebus*:

Well, Protarchus, should we say that the whole universe is ruled by unreason, irregularity and chance, or on the contrary, as some of those who came before us said, say that *nous* and a marvelous organising intelligence steer (*diakubernan*) it.⁵²

We might take this in conjunction with Aristotle, *Physics*, III/4, 203b7 ff., where just after the 'surrounds all and steers all' passage, the *apeiron* is referred to by

Aristotle as τὸ θεῖον, the divine. In Plato, a better translation might be ‘govern’ rather than ‘steer’, as govern has greater connotations of rational, conscious control.⁵³

We need to be careful about this piece of evidence from Plato. First, we cannot be sure that Anaximander is being alluded to here. There were several Presocratics who used the idea of steering, as we have seen. Second, Plato may be seeing what he wants to see in Presocratic philosophy and so he interprets steering in terms of some form of intelligent design, along the same sort of lines as he argues for in the *Timaeus* and elsewhere. One might have doubts as to whether this quite fits with Anaximander who has no independent deity as far as we are aware. Aristotle says that the *apeiron* is the divine on the basis that it is ἀθάνατον γὰρ καὶ ἀνώλεθρον (immortal and indestructible) rather than for any intellectual quality.

The second model for steering might be something rather more like organic growth. Here it is interesting to emphasise that the *apeiron* surrounds all as well as steers all and to look at some of the connotations of that description. The verb translated as ‘surrounds’ here is *periechein*, which can have senses of to defend, to protect, or to guard. This is the same verb we saw in our first passage in this chapter, where the Caddis fly larvae ‘surrounded’ themselves with spine-like bark. An interesting use of a cognate of *periechein* though is *to periechon*, which in Theophrastus can be the envelope of a seed.⁵⁴ If we take that seriously, that is good evidence for a more biological take on the cosmogony, as the *apeiron* might then be thought to function as the envelope of the seed, the *gonimon* being the seed and the earth and rest of the *cosmos* being the product of the seed’s growth. In this sense the *apeiron* might be thought to steer the production of the earth and the *cosmos* more generally. I would also note that the seed will need to take in nutrition in order to grow and to form something more complex, and that ‘nutrition’ will be further differentiated matter or qualities taken in from the *apeiron*, and here too the *apeiron* might be thought to be steering. We will come back to these issues when we look at cosmogony in a later chapter. For the moment, all I want to do is assert the existence of steering in Anaximander, raise the possibility that it may affect what goes on in the *cosmos* at quite a fundamental level by looking at other uses of steering, and suggest that it then may also be important in Anaximander’s account of zoogony.

I have raised questions about making choices of interpretation for Anaximander and seeing what we like in philosophy or science in Anaximander. Here I want to point out that I don’t subscribe to Intelligent Design or the organic view of the origins and development of life or the universe which I have sketched

here. However, I do think they are serious contenders for interpreting Anaximander and that it is hard to impose anything like modern evolutionary theory.

Uniformitarianism

One important theme for this book will be that Anaximander was a uniformitarian. That is, in questions such as the origins of the *cosmos* or the origins of life, he adopted theories which invoke the same sort of processes which we can still find going on in the world today rather than theories which invoke unique processes. One important aspect of Milesian cosmogony was that the underlying processes which generate the *cosmos* are ongoing, unlike mythical or theogonical accounts. The separating out and interchange of elements does not cease once the *cosmos* has been formed in Anaximander, nor does the condensation and rarefaction of elements in Anaximenes. There is, of course, progress in that the *cosmos* has been formed, but the basic processes remain in action. If the Caddis fly hypothesis is correct, then Anaximander is a uniformitarian with respect to zoogony as well as with respect to cosmogony. So I would disagree with Barnes who says that:

There is no suggestion that this mode of reproduction occurred more than once.⁵⁵

On the contrary, if our passage does describe the life cycle of the Caddis fly, then this mode of reproduction happens every year. There is a spontaneous generation of Caddis fly larvae, they build cases for themselves and then undergo metamorphosis on a yearly basis. We might wonder why Anaximander chooses the Caddis fly. He obtains several important components for a theory of the natural origin of animals, and could claim to have a clear example of these components. He gets the initial (and ongoing) generation of living things from moisture. He gets the transfer of an aquatic life form to something which lives on the earth and in the air.

With this metamorphosis he gets an example of an apparently simple life form (the Caddis grub) transforming into an apparently much more complex life form (the Caddis fly) and doing so relatively swiftly. He might have chosen other flies but here is something indigenous to ancient Greece which comes from streams rather than any human-generated water source. There are, then, some very positive things we can say about Anaximander's zoogony. Against a background of myth and theogony, he is the first person we are aware of who

sees the origins of animals as an entirely natural event. What is more, his theory appears to have some basis in observation.

One might also argue that Anaximander is a uniformitarian with respect to zoogony as opposed to Homer and Hesiod. Homer and Hesiod see the origins of life, in particular the origins of humans, as special and unique events. Anaximander does not. One more thing he may get out of the Caddis fly life cycle is that it is very predictable, reliable and of course cyclical. It occurs at the same time, in the same way each year and, for Anaximander, there is no sense of any need for the caprice or the intervention of the gods in order for this process to recur. Finally on this theme, it is critical that human beings are brought into this scheme of zoogony. They are now part of the natural order, on the same footing as the rest of the animals with entirely natural origins. There is no sense of a special relationship to the gods for humans, either in terms of their origins or how they live their lives.

Theory quality

The standard criticism of the first passage we looked at is that, as ordinarily translated, this describes no known creature and that the zoogony here is, as Barnes has put it, a 'genial fantasy'. With the new translation and the Caddis fly hypothesis, we have a very good match.⁵⁶ We might question whether this is something that Anaximander had observed for himself, or something that he learned through acquaintance with folk knowledge. In either case though, the account of the life cycle of the Caddis fly seems to be based on good observation. The idea that Anaximander may have based some of his theories on folk knowledge is one that will recur in several places in this book. So, too, will the notion that Anaximander consistently made uniformitarian choices for the question of origins. The sort of processes he envisages for the origins of life are the sort of processes we can still see going on in the world today. Whether uniformitarianism is a merit in itself is something which is open to debate, especially as current theories of the origins of the universe are not uniformitarian. However, there is a further coherence aspect to Anaximander, which is that he consistently chooses uniformitarian options. The idea of change based on the idea of metamorphosis is an intriguing one. It is possible that Anaximander got quite a lot out of that idea for his natural account of the origins and development of life. While we may think he was mistaken to take metamorphosis as a model, in the context of developing the first natural account of the origins of life this is

a plausible possibility. In relation to water being implicated in the origins of life, there are Babylonian and Egyptian mythological accounts of the origin of life from water and it can be argued that life from water is also implicit in Thales. One might also make some sort of a case for that in Homer, as he treats Okeanos as the 'first origin of all';⁵⁷ through the seas and the rivers, this then nourishes everything,⁵⁸ although of course there are more specific accounts of the origin of human beings in Homer. Whether any of this has any effect on Anaximander's thought is open to question. One important shift effected by the Caddis fly hypothesis is that Anaximander could have constructed his theory of the origins of life from his own observations or folk knowledge, so we have no particular need to explain in terms of precursors. A more important question, I think, is how different Anaximander's view is. It would seem radically different from the mythologies of the Egyptians, Babylonians and indeed Homer and Hesiod, explaining the origins and development of life without any recourse to the actions of the gods. One further point is that unlike mythologies, Anaximander does not specify separate origins for men and women. As Naddaf has put it:

Man no longer has the temporal and logical priority over woman that he possessed in the mythical accounts of the Greeks. Moreover this is the first rational/naturalistic account of the origin of humanity of which we are aware.⁵⁹

Finally, of critical importance is the question of whether we wish to judge Anaximander by similarity to the content of modern theories or by other criteria? The Caddis fly hypothesis discards any similarities with modern evolution, but may have other epistemic merits.

Conclusion

The Caddis fly hypothesis opens up considerable new possibilities for assessing the work of Anaximander. In particular, the idea that Anaximander may have used metamorphosis as a key model for important changes throws new light on some other zoogony passages and on some of the cosmogony as well. Anaximander's zoogony is a serious attempt to explain the origins of life by natural means, in a non-arbitrary manner, with observational support. As with Anaximander's cosmogony, his zoogony eschews *ad hoc* explanations in favour of law-like ongoing processes.

One objection to the Caddis fly hypothesis might be how much can we rely on a tight analysis of the Greek? Especially, one might say, as in questioning whether

Aristotle and Theophrastus are good witnesses, and questioning whether they had access to the texts of Anaximander, I have somewhat undermined the reliability of such evidence. My first answer would be we can only work with what we have, so we analyse this passage in the best way that we can. My second answer would be that this criticism cuts both ways. We cannot be sure of the Caddis fly interpretation, but we cannot be sure of other interpretations which have no reference in the natural world either. This is why I am so keen to emphasise that we need to be clear about the criteria we have for accepting one interpretation rather than another.

A second objection would be that we have no independent evidence that Anaximander knew about Caddis flies; his theorising may well have been 'genial fantasy'. Virtually any 'genial fantasy' will have an unintended correlate in nature if we think hard enough. However, it is perhaps significant that this candidate is not just any animal, but one that fits the *ta prôta zoa* description very well and gives Anaximander an interesting and contextually plausible account of the origins and development of life.

We have virtually nothing on how Anaximander believed that life developed beyond the Caddis fly, except that metamorphosis may play a significant part in demonstrating that more-complex life forms may develop from less-complex life forms. The Caddis fly example also shows that aquatic life forms may develop into land- or air-based creatures. Anaximander was very far from any modern theory of evolution. He had no concept of the roles of chance mutation, adaptation or survival of the fittest. If my suggestion is right though, he believed that the *apeiron* in some way steered the formation of the *cosmos* and of living things. Unfortunately, we do not have enough evidence here to pin down the precise nature of that steering effect in zoogony. None of this should detract from Anaximander's achievement of suggesting natural origins for animals and mankind, and trying to give that some form of empirical foundation.

This chapter has introduced some important themes for this book. If we do not force Anaximander into similarity with modern scientific theories, we may find greater epistemic merit in his views. There are more biological, organic alternatives to physical and mechanical interpretations of Anaximander and we need to be aware of the options and the choices we make in translating passages and understanding his views.

Anaximander and Meteorology

With Anaximander, in the few passages that have been preserved on this topic, we have the first extant meteorology. We do have Thales' explanation of earthquakes, but we have nothing on the explanation of other meteorological phenomena.¹ Meteorology for the ancient Greeks, if we take Aristotle's *Meteorology* as a guide,² included weather phenomena, water phenomena and the causes of winds and earthquakes.³ The standard view on Anaximander's meteorology is that he gave natural explanations for phenomena such as thunder and lightning which had previously been explained by reference to the gods. This view has been criticised for assuming too quickly that this was Anaximander's intention. Here I will argue something stronger: that the five phenomena Anaximander explains are the same five phenomena referred to in an important passage in Hesiod. This is deliberate allusion not coincidence and Anaximander sets his natural explanations in direct contrast to the theological explanations given by Hesiod. This fits a more general pattern of Presocratic targeting of Homer and Hesiod by Presocratic thinkers.⁴ One thing that needs careful consideration though is whether the grouping of these five phenomena was due to Anaximander or is a construct of the doxography. I offer some arguments in favour of Anaximander. As with the zoogony, there are indications that Anaximander was conversant with folk knowledge in relation to meteorology. Theory quality and originality are again issues. I argue against West that Anaximander's meteorology is radically different both from that of Hesiod and of previous cultures. In terms of quality, naturalism was not the only merit of Anaximander's meteorology. It also had breadth, depth, invariance and economy: economy being important not only within the meteorology, but also in the way that the meteorology coheres with explanations in other areas for Anaximander.

Anaximander's meteorology: Stobaeus and Pseudo-Plutarch

There are important parallel passages in Stobaeus and Pseudo-Plutarch. Stobaeus tells us that:

Περὶ βροντῶν ἀστραπῶν κεραυνῶν πρηστήρων τυφῶνων.

Ἀναξίμανδρος ἐκ τοῦ πνεύματος ταῦτ' εἶπε συμβαίνειν· ὅταν γὰρ περιληφθὲν νέφει παχεῖ βιασάμενον ἐκπέσῃ τῇ λεπτομερείᾳ καὶ κουφότητι, τόθ' ἡ μὲν ῥῆξις τὸν ψόφον, ἡ δὲ διαστολὴ παρὰ τὴν μελανίαν τοῦ νέφους τὸν διαυγασμὸν ἀποτελεῖ.⁵

Concerning thunder, lightning, thunderbolts, hurricanes and typhoons.

Anaximander said that these come about because of wind. Whenever it is enclosed in a thick cloud and then forcibly breaks out, due to its fineness and lightness, then the bursting makes the noise, and the rent against the blackness of the cloud is the lightning flash.

Pseudo-Plutarch has something almost identical:

Περὶ βροντῶν ἀστραπῶν κεραυνῶν πρηστήρων τε καὶ τυφῶνων.

Ἀναξίμανδρος ἐκ τοῦ πνεύματος ταυτὶ πάντα συμβαίνειν· ὅταν γὰρ περιληφθὲν νέφει παχεῖ βιασάμενον ἐκπέσῃ τῇ λεπτομερείᾳ καὶ κουφότητι, τότε ἡ μὲν ῥῆξις τὸν ψόφον ἡ δὲ διαστολὴ παρὰ τὴν μελανίαν τοῦ νέφους τὸν διαυγασμὸν ἀποτελεῖ.

Concerning thunder, lightning, thunderbolts, hurricanes and typhoons.

Anaximander, all these come about because of wind. Whenever it is enclosed in a thick cloud and then forcibly breaks out, due to its fineness and lightness, then the bursting makes the noise, and the rent against the blackness of the cloud is the lightning flash.⁶

The only real difference here is that Stobaeus has εἶπε (he said) where Pseudo-Plutarch has πάντα (all). That may be significant depending on how much emphasis we want to put on *all* of the phenomena being explained in a similar manner here. The Pseudo-Plutarch passage is that printed by Diels-Kranz, Kahn, Kirk, Raven and Schofield and in Graham.⁷ The second sentence may look slightly ungrammatical but is typical of Pseudo-Plutarch's style as he often lists views on topics quite tersely. The first sentence in each passage is a section heading. It is important here to preserve the section heading as something distinct from the views of Anaximander on this topic. Both Stobaeus and Pseudo-Plutarch use these section headings and then give the views of various thinkers on those topics. It may be significant that in each case Anaximander's views are given first on this topic.

Concerning thunder, lightning, thunderbolts, hurricanes and typhoons

Thunder, lightning and thunderbolts are all quite straightforward in their meaning here. The difference between lightning and thunderbolt is roughly that between the modern terms ‘sheet lightning’ or ‘cloud to cloud’ lightning and ‘cloud to ground’ lightning. I have translated *prêstêr* as ‘hurricane’ but it can also mean ‘waterspout attended with lightning’ according to LSJ. In some contexts this latter sense is evident in that the *prêstêr* is said to have emerged from the sea. *Tuphos* is usually translated as typhoon, though it can also mean whirlwind. As we shall see in a moment, winds are associated with the wind god Typhoeus in Hesiod. It has often said that thunder (*brontê*), lightning (*astrapê*), thunderbolts (*keraunos*), hurricanes (*prêstêr*) and typhoons (*tuphos*) are all phenomena which the Greeks of the time considered to be caused by the intervention of the gods. Vlastos comments that:

Lightning, thunder, a storm, an earthquake were ‘signs from Zeus’ that could stop a meeting of the Law Courts or of the Assembly;⁸ religious feeling for an eclipse could overrule military intelligence to cause the greatest disaster ever suffered by Athenian arms.⁹

I will refer to these five meteorological phenomena as the ‘Anaximander phenomena’. Anaximander, and those who followed him, gave natural explanations for classes of phenomena (all instances of thunder) where Homer and Hesiod focused on single instances of these phenomena.¹⁰

A more sceptical view here is that while this may be an interesting fragment about meteorology, can we really take this as conclusive evidence of a conscious, intentional rejection of the supernatural in favour of the natural?¹¹ Taken on its own, this fragment may seem to give natural explanations but these may be accidental; it is, after all, one fragment and very far from the whole picture. To take an example from a different Presocratic though, Xenophanes says that:

What is called Iris is also a cloud, red, purple and greenish yellow to see.¹²

In both Homer and Hesiod, Iris is goddess of the rainbow and messenger of the gods. In Homer, Zeus uses the rainbow as a portent for humans (e.g. Homer, *Iliad*, XI/26 ff., XVII/547 ff.). In relation to this passage Lloyd says that:

It may be that the thrust of Xenophanes’ point (and of other such ideas attributed to other early philosophers) is not so much what is said but what is implicitly denied. Iris – the message is – is no messenger of the gods, no omen for the

future: even though we should beware of assuming that every time some Greek before Xenophanes saw a rainbow they automatically thought of it as a portent.¹³

Lloyd recognises the possibility of Xenophanes' theory being an implicit rejection of the rainbow as a portent, but says:

If that *may have* been the thrust of Xenophanes' point, that is just conjecture on our part.¹⁴

Lloyd generalises this to 'other such ideas attributed to the early philosophers'.¹⁵ So one issue we must face is whether similar ideas about what Anaximander's intentions may have been are just conjecture on our part or whether we have some further evidence. In relation to Xenophanes, I believe we do have evidence of a systematic attack on Homer and Hesiod, whether that is explicit,¹⁶ or implicit.¹⁷ Xenophanes also has natural explanations for other phenomena which were commonly taken to be supernatural. So Xenophanes, Fr. 39 says that:

Xenophanes held that concerning the star-like phenomena on ships, which are called by some Dioskouri, they are small clouds which glimmer due to a certain kind of movement.

The Dioskouri were divine twins who were considered to be helpful to travellers in general and to sailors in particular. The association between the Dioskouri and St Elmo's fire is now reckoned to be early, around the seventh or sixth century BCE.¹⁸ It is also notable in this context that Cicero in *On Divination* picks out Xenophanes as someone who denied the validity of divination,¹⁹ as both St Elmo's fire and the rainbow were traditionally seen as portents.²⁰ There is then further evidence that Xenophanes did want to deny the rainbow as a portent, along with other phenomena.²¹ There is further evidence for Anaximander too.

Anaximander and Hesiod

I think we can say something much more positive than 'these are the sorts of phenomena attributed to interventionist gods.' These are precisely the phenomena which Homer and Hesiod attribute to the intervention of the gods and to Zeus in particular. In Homer, there is a common association of the thunder and thunderbolt of Zeus,²² as well as the thunder and lightning of Zeus.²³ In the *Odyssey* there is a recurring motif of a ship being hit by the thunderbolt of Zeus.²⁴ Early on in Hesiod's *Theogony* we find that:

She bore the proud-hearted Cyclops, Thunderer, Lightning and Vivid Lightning, who gave Zeus his thunder and forged his thunderbolt.²⁵

When Zeus enters the battle against the Titans:

From heaven and Olympus he came with lightning and thunderbolts flew from his hand amid thunder and lightning, trailing sacred (*hierên*) flame.²⁶

There are many similar passages in the *Theogony* where Zeus is associated with thunder, lightning and the thunderbolt.²⁷ If we want a passage with all five of the terms that Anaximander mentions, then we need look no further than the tale of Zeus against the Titans in the *Theogony*, 845–6:

καῦμα δ' ὑπ' ἀμφοτέρων κάτεχεν ἰοειδέα πόντον βροντῆς τε στεροπῆς τε πυρός
τ' ἀπὸ τοῖο πελώρου πρηστήρων ἀνέμων τε κεραυνοῦ τε φλεγέθοντος.²⁸

The conflagration held the purple waters, from the thunder and lightning and the fire of the monster, from the hurricane winds and the fiery thunderbolt.

So we have thunder, lightning, hurricane and thunderbolt, all as part of a battle of the gods. Zeus then uses his weapons of thunder, lightning and thunderbolt to defeat Typhoeus, who produces strong winds and wet winds. It is notable that the same creature is described as lawless (*anomon*) earlier on,²⁹ and that as Zeus descends he is trailing a sacred (*hieren*) flame.³⁰ This passage is significant in that this looks like a targeting not just of the general views of Homer and Hesiod but of a specific passage that would have been well known to the Presocratic Greeks. We should also note in relation to the Hippolytus passage we looked at that gave natural explanations for wind and rain, that Zeus as the cloud-gatherer is a standard epithet in Hesiod; in the *Iliad* and *Odyssey*,³¹ Zeus also produces rain,³² and generates storms.³³ That winds are caused by the gods is again standard in Homer and Hesiod.³⁴ Greene³⁵ has argued that this passage of the struggle of Zeus against Typhoeus describes a volcanic eruption, specifically that of Etna in 735 BCE. I am not convinced by this, but even if Greene were correct, the issue of aetiology still stands. Hesiod, in line with the rest of the *Theogony*, attributes these occurrences to the gods, Anaximander to natural causes.

Anaximander or later source?

It is worth looking a little more closely at the nature of the passage on thunder, lightning, thunderbolts, hurricanes and typhoons. It is important to recognise here that the first sentence in our passage is, in fact, a section heading in both

Stobaeus and Pseudo-Plutarch. So 'Concerning thunder, lightning, thunderbolts, hurricanes and typhoons' stands away from the rest of the text. Stobaeus and Pseudo-Plutarch give first the views of Anaximander, then the views of many other thinkers. The passage is sometimes presented with the heading incorporated into the passage, which can give a stronger impression that the meteorological phenomena referred to are Anaximander's own category.

Is this Anaximander's own category though, or is it the doxographer's? Did a previous doxographer, then followed by Pseudo-Plutarch and Stobaeus, generate the category of 'on thunder, lightning, thunderbolts, hurricanes and typhoons' and then gather together the scattered remarks of the philosophers on this issue and place them in this category? Or did Anaximander generate this as a specific topic which later thinkers also treated as a specific topic? The first place in which we can find these five phenomena gathered together as a section heading is in Aristotle's *Meteorology*.³⁶ In book one, chapter one of the *Meteorology* Aristotle groups together thunderbolts, typhoons and hurricanes as something he wishes to pay attention to. Aristotle actually deals with thunder and lightning in *Meteorology*, II/9 and with thunderbolts, typhoons and hurricanes in *Meteorology*, III/1. As Pseudo-Plutarch and Stobaeus, following Aetius, all use this and other section headings from the *Meteorology*, could it be that Aristotle initiates this category and later doxographers then include assorted views of the Presocratics? The first paragraph of *Meteorology*, II/9 is:

Let us speak of lightning and thunder, and then typhoons, hurricanes and thunderbolts. The same principle applies to all of them. As we have said, there are two types of exhalation, the wet and the dry.³⁷

The key question here is whether it is a coincidence that Aristotle groups together the five phenomena that we find in the Hesiod passage or whether he is building on a Presocratic tradition which goes back to Anaximander. I do not think this question can be answered decisively one way or the other, though I do think the evidence leans heavily in favour of Anaximander alluding to Hesiod and a tradition being built on that. Here are six arguments in favour of that view.

1. The first consideration is that this is a slightly odd group of phenomena for Aristotle to bring together, if he is generating this group himself. It is not as if these five phenomena make up some natural kind or are exhaustive of some particular type of meteorological phenomenon or some particular type of explanation for Aristotle. One might argue that the reason that Aristotle treats these five phenomena together is that 'The same principle applies to all of them.' These phenomena are all explained by Aristotle in

terms of his theory of wet and dry exhalations. However, Aristotle also explains several other phenomena in terms of wet and dry exhalations. Within this section he mentions the formation of clouds, in *Meteorology*, II/4 he discusses winds in terms of wet and dry exhalations,³⁸ and in *Meteorology*, II/4 he discusses how earthquakes are a consequence of the wet and dry exhalations.³⁹ So this group is not by any means exhaustive of phenomena to be explained by wet and dry exhalations.

2. It may be significant that Aristotle's views are mentioned by Stobaeus and Pseudo-Plutarch on a par with other views, both Presocratic and post-Aristotle. There is no sense that Aristotle originated the category of thunder, lightning, thunderbolts, hurricanes and typhoons or that his views on these phenomena are more important or significant than those of the others mentioned.
3. His views are simply reported in chronological sequence, after those of the Presocratics and before those of Chrysippus and Strato. There is no differentiation between Aristotle and pre-Aristotle views. It is also notable that Anaximander's views are given first in both accounts we have, as Pseudo-Plutarch and Stobaeus are by no means strictly chronological in arranging their doxography.⁴⁰ It seems unlikely, then, that Aristotle was the first person to group these five phenomena together and Anaximander is the first person we have evidence for having done so. Against this, one might say that the only predecessors that Aristotle mentions in the relevant section of the *Meteorology* are Empedocles, Anaxagoras and Cleidemus. There is no mention of Anaximander. This might be explained in several ways, not least that Aristotle is hardly a meticulous historian when he sets out opposing views to criticise, he does not mention Anaximander very much in other works, and that he may only have oral reports of Anaximander.
4. It may also be important that Anaximander believes all of these phenomena can be explained by wind, giving some coherence to these five phenomena as a category for Anaximander. One might object that we only get *πάντα* in the Pseudo-Plutarch passage. In reply, one might say that the difference is only between 'Anaximander said that these come about because of wind' and 'Anaximander, all these come about because of wind'. The *πάντα* may make matters slightly more emphatic, but leaving it out does not really alter the sense of the sentence. Here it is notable that Pseudo-Plutarch uses *πάντα* in relation to Anaximander but not Aristotle while Stobaeus uses it for neither, even though we have *πάντων* in the *Meteorology*, II/9 passage. This, of course, does not directly show that Anaximander was alluding to Hesiod,

but if this group does have some coherence for Anaximander, it shows the doxographers are not then creating this category themselves and bringing together disparate strands of Anaximander's thoughts under that category if Anaximander explains all of these phenomena in the same manner.

5. This would not be the only allusion to the early poets in Anaximander in important cosmological contexts, as we will see. There is also a broader Presocratic pattern of allusion to Homer and Hesiod on these issues of which Anaximander is arguably an important part.
6. This would not be the only set of natural explanations in Anaximander which explain phenomena given non-natural explanations, either by contemporary Greek culture or by Homer and Hesiod more specifically. Anaximander has a natural explanation of eclipses in terms of the closure or occlusion of the apertures through which we see the heavenly bodies. Anaximander was at least perceived by others to deal with earthquakes in a natural manner.
7. Finally, it is also highly significant that Stobaeus continues directly on from his account of Anaximander on thunder, lightning, thunderbolts, hurricanes and typhoons with his account of Anaximenes on the same topic. So Stobaeus, I, 29, 1 tells us that:

Anaximenes, the same (as Anaximander), adding what happens with the sea, which flashes when broken by oars.

This very strongly suggests that these five phenomena are a group for Anaximander and that Anaximenes also treats them as a group, adding something extra in terms of explanation. So without being able to come to a definitive answer to our question of whether some later doxographers fitted Anaximander's views into the category of thunder, lightning, thunderbolts, hurricanes and typhoons or whether Anaximander generated this category as part of an allusion to Hesiod, I believe the evidence leans in favour of the latter.

There are two other possibilities which should be mentioned here. First, it is Aristotle who first alludes to the Hesiod passage with the heading of *Meteorology*, II/9, which is why we get that grouping of phenomena there. That becomes a doxographer's category and Anaximander's views are reported under that heading. Although an outside possibility, I find this unlikely. Second, a Presocratic other than Anaximander grouped these five phenomena together with the intention of alluding to Hesiod. Aristotle picks up on that tradition, the doxographers pick up on Aristotle's section heading and Anaximander's views are reported under that heading. Again, this is possible but we have no evidence

to indicate which of the Presocratics giving explanations to all five of the Anaximander phenomena this might be. Given that both Pseudo-Plutarch and Stobaeus treat Anaximander first and to some extent treat him slightly differently and more fully, if we are going for a Presocratic origin for the category of on thunder, lightning, thunderbolts, hurricanes and typhoons, then we have to go for Anaximander.

Allusion, targeting and the Presocratics

If Anaximander did allude to Hesiod in the passage on thunder, lightning, thunderbolts, hurricanes and typhoons, this is neither unique nor unusual among Presocratic thinkers. In my *The Presocratics and the Supernatural*, I argued that figures such as Anaximenes, Heraclitus, some of the Hippocratic authors, Xenophanes, Anaxagoras, Leucippus and Democritus all alluded to Homer and/or Hesiod in arguing for natural explanations for phenomena.⁴¹

I also argued there for something which I called the 'targeting thesis'.⁴² The targeting thesis is that among many of the Presocratics, we find a comprehensive, consistent and targeted rejection of non-natural explanations. Comprehensive in that we find a great number of natural explanations of phenomena that had previously been explained in terms of non-natural intervention. Consistent in that there are basic principles within each thinker used to explain the phenomena rather than ad hoc explanations. They were targeted in three senses. Targeted on what was commonly attributed to intervention by the gods. Targeted on the most important cases and hardest cases to demonstrate natural explanation. Targeted in particular on Homer and Hesiod, both in terms of their general views and in terms of well-known passages. In particular the targeting thesis here, if it can be substantiated, entails that there was a conscious and systematic rejection of non-natural explanation in favour of natural explanation.⁴³

Specific important examples here are Anaximenes on rainbows and on earthquakes, Xenophanes on the rainbow, on divination⁴⁴ and on St Elmo's fire,⁴⁵ the Hippocratic author of *On the Sacred Disease* and their rejection of any non-natural cause for the sacred disease,⁴⁶ Anaxagoras on rainbows, earthquakes and divination,⁴⁷ Leucippus and Democritus on the gods and on images.⁴⁸ Anaximander, in my view, fits this pattern very well. It is also interesting that there are a number of Presocratics following Anaximander who deal with thunder, lightning, thunderbolts, hurricanes and typhoons. The same reservations about the evidence should apply as with Anaximander, but Stobaeus, who

is the fuller source, mentions Metrodorus, Archelaus, Xenophanes, Diogenes, Empedocles and⁴⁹ Leucippus as having views on some of these phenomena. He has Anaximenes and Anaxagoras as having views on all five, along with Aristotle, Chrysippus and Strato. Democritus is reported on four of these phenomena, but not on typhoons and Heraclitus on three, again lacking typhoons and slightly oddly thunderbolts as we know that Heraclitus did mention them.⁵⁰ Both Democritus and Heraclitus deal with winds though and as the passage in Hesiod has Typhoeus a god of winds, that may be enough for all five.

Other meteorological fragments

I have concentrated here on the Stobaeus and Pseudo-Plutarch fragments, for obvious reasons. What of the other fragments though? Seneca, *Natural Questions*, II/18 tells us that:

Anaximander explained everything in terms of wind. Thunder, he said, was the sound of smitten cloud. Why is there inequality? Because the blows themselves are unequal. Why is there thunder in a cloudless sky? Because even then air jumps through the thick and cut atmosphere. Why sometimes is there lightning but not thunder? Because the air is weak, not strong enough to support flame, but strong enough to support sound. What is the actual lightning flash? Disturbance generated by air dissipating and rushing together again, producing weak fire which cannot escape. What is a lightning bolt? The rapid motion of more active, denser air.⁵¹

Hippolytus also tells us that:

Winds happen when the lightest vapours of the air are separated off and gathering together are set in motion. Rain is due to the vapour which comes up from things under the sun. Lightning happens when wind escapes by breaching clouds.⁵²

Finally, Pseudo-Plutarch gives us some further information on wind:

Concerning winds.

Anaximander believed wind to be flowing air, the finest and moistest parts of it being set in motion and melted by the sun.⁵³

The Seneca passage gives us some more detail and again emphasises that Anaximander explained all these phenomena in terms of air. The Hippolytus passage gives us an account of the origin of winds. We are told that 'Winds

happen when the lightest vapours of the air are separated off and gathering together are set in motion.’ That is quite important in its way. It is fine for the Stobaeus and Pseudo-Plutarch passages to have meteorological phenomena explained in terms of wind, but what, one might ask, of the wind itself, especially as the origins of winds are explained in terms of the gods in Homer and Hesiod? It is then significant that Anaximander gives an entirely natural origin to winds. Rain, too, is given an entirely natural origin here. Finally, Pseudo-Plutarch confirms that wind has a natural origin by saying that ‘Anaximander believed wind to be flowing air, the finest and moistest parts of it being set in motion and melted by the sun.’

Anaximander and folk meteorology

There is a very interesting article by Shelley entitled ‘*The Influence of Folk Meteorology in the Anaximander Fragment*’.⁵⁴ In it he argues that:

Scholars have assumed that Greek myths supplied Anaximander with his ideas on meteorology, but this assumption has escaped questioning simply due to a lack of competition. In this section folk meteorology is advanced as a competing source, specifically as the source of the concept of justice.⁵⁵

The notion that Anaximander may have been inspired by folk meteorology is both original and very interesting. It is also true that scholars have assumed that Greek mythology was the source of Anaximander’s comments in a rather general manner, without being able to tie that down very specifically. Two advantages of the view I have argued for above are that we can tie down Anaximander’s comments as reported by Stobaeus and Pseudo-Plutarch very specifically in a famous passage in Hesiod. We do not then have to rely on folk meteorology as the source of Anaximander’s comments. Having said that, I would not wish to deny that folklore may have been significant for Anaximander. That Anaximander had some folk knowledge may be shown from the following passage from Cicero, *De Divinatione*:

Many things are foreseen by doctors, steersmen, and so too by farmers, but I do not call these divination, not even, in fact, when Anaximander, the natural philosopher, warned the Spartans to leave their city and to sleep in the fields with their arms, because an earthquake was near. The entire city fell down and the mountain edge of Mount Taygetus was ripped away like the stern part of a ship when in a storm.⁵⁶

If this anecdote is true, we must wonder what sort of knowledge Anaximander had in order to be able to predict an earthquake. Some form of folklore concerning the behaviour of animals prior to an earthquake or the behaviour of winds prior to an earthquake would seem the most likely possibility.

Sources for Anaximander's meteorology

West has commented that:

Anaximander inherited an established Greek tradition of materialistic meteorology. The further he goes outside our earth, the more his explanations become theological and non-Greek in inspiration; the nearer he is to earth, the more they are physical and follow native lines of thought.⁵⁷

I'm afraid I disagree with every part of this. What is this 'established tradition of materialistic meteorology'? It can hardly be Thales, as we only have evidence of him in relation to earthquakes. If anyone else had materialistic explanations, not only Aristotle but the whole doxographic tradition after him failed to mention them. I do not see, and I do not see that West provides any evidence for the assertion that the further Anaximander went outside the earth, the more theological and the more non-Greek his explanations became. Doubtless in Homer and Hesiod we can find a sense that meteorological phenomena can be affected by physical phenomena. One might debate whether that pertains to the magnitude of the phenomena (so earthquakes can be made greater by winds) or to whether phenomena occur at all without being caused by the gods. Whatever the answer to that, this is a long way from a materialistic meteorology. The key here is that Anaximander denies any role at all to the traditional gods in the explanation of meteorological phenomena. He may well have built on some ideas of his predecessors but he has stripped those ideas of any involvement with the gods. Nor is it the case that Anaximander's ideas are more theological the further he goes from the earth. I do not see that any of his explanations in meteorology are in any way theological or that there is any difference between his explanations of meteorological phenomena close to the earth or far from the earth. West goes on to say that for theories explaining thunder and lightning in terms of clouds splitting due to the wind inside them:

It would be a mistake to suppose they originated with the Milesians. Passing allusion in Hesiod shows that his ideas were not very different. *Aer* draws up moisture from the rivers, is carried hither and thither by wind, and may turn into

rain or remain as wind. Thunder, lightning, earthquakes are caused by Zeus or Poseidon, but at the same time be spoken of as inflated by winds.⁵⁸

There is a sense in which this is correct. There were explanations of meteorological phenomena prior to the Milesians, which they both built on and transformed. A certain type of meteorological explanation does begin with the Milesians and, in particular, with Anaximander. Some similarities with Hesiod in terms of explanation of some phenomena do not prove much. What is far more important is that when Anaximander is alluding to Hesiod, he distances himself and gives an entirely different sort of explanation for meteorological phenomena.

As is probably already clear, I do not recognise Hesiod as having generated an 'established tradition of materialistic meteorology'. He mentions the rain cycle, which one might say is so basic as to virtually count as a phenomenon in itself. The real issue is why phenomena occur. For Hesiod that is because they are caused by deities such as 'Zeus or Poseidon', for Anaximander these phenomena have entirely natural causes. In relation to wind and rain, as we saw above, Zeus is termed 'cloud gatherer' by both Homer and Hesiod and Zeus produces wind, rain and storms.⁵⁹ West further says:

Anaximander's dependence on this tradition is shown most clearly by his reliance on vapours drawn up by the sun.⁶⁰

I do not see that this is the case. First, the idea of water being evaporated by the sun and then falling again as rain is pretty ubiquitous and we can hardly rule out independent discovery, especially as one can observe water evaporating under strong sunlight and observe mist condensing to water droplets. Second, there is a strong possibility of folk knowledge here. As we have seen, it is entirely plausible that Anaximander had access to and paid close attention to folk knowledge. That Anaximander knew of Hesiod is in my view indisputable, but that he depends on him for his account of the rain cycle is not at all clear. It does not seem possible that the vapour theory was first formulated for this cosmology.⁶¹ If Anaximander did make a direct allusion to Hesiod on meteorological phenomena, he distances himself from him in a significant manner.

Theory quality

How good is Anaximander's meteorology? In modern terms, of course, it is a failure, as we do not explain these phenomena in these ways. Was it, as Lloyd has put it, 'a mere act of faith – we might even say bluff – to claim to be able to explain,

let alone control, the phenomena in question?’⁶² The standard reply here is that the new natural theories of the Presocratic natural philosophers were at least the right type of theories, as they cited only natural entities. Better explanations, still citing only natural entities, would follow. Although I think naturalism is a merit of Anaximander’s meteorology, I believe it is far from being the only merit.⁶³ Let us begin with two important aspects, breadth and depth. Anaximander proposes to explain all of the phenomena of thunder, lightning, thunderbolts, hurricanes and typhoons in terms of wind. Pseudo-Plutarch’s passage is perhaps a touch more emphatic in this respect with its *panta*, but it is clear in the Stobaeus passage as well that all of the five phenomena mentioned are to be explained in terms of wind. This is a broad spectrum of phenomena which are being explained in terms of a single *explanans*, so we may say that Anaximander’s theory is parsimonious as well. In relation to this, it is significant to note that ‘bursting’ as an explanation occurs frequently in Anaximander. We see it here in relation to meteorology, we have seen it in relation to zoogony, we will see it again in relation to cosmogony and to the function of the heavens. There is then system and parsimony in the way that Anaximander explains natural phenomena. Further, all instances of each of these phenomena are explained in terms of wind. The *hotan*, whenever, in each passage makes this entirely clear. Although invariance might seem a small merit in modern theories, in context this is enormously important in relation to Hesiod. Sometimes meteorological phenomena in Hesiod seem natural, sometimes they are due to the intervention of the gods but there is no sense of invariance in Hesiod.⁶⁴ This is a general theory of considerable scope. The theory also has depth. What are winds for Anaximander?

Anaximander believed wind to be flowing air, the finest and moistest parts of it being set in motion and melted by the sun.⁶⁵

How do winds occur?

Winds happen when the lightest vapours of the air are separated off and gathering together are set in motion.⁶⁶

So there is depth to Anaximander’s theory. If we want to know the cause of some meteorological phenomena, the answer is wind. If we want to know what wind is, or what causes wind, there are further answers. All of this is interesting in relation to two more passages in Hesiod. At *Theogony*, 307, Typhoeus is referred to as *anomon* (lawless). I will develop theme of regularity and law-like behaviour in Anaximander, but already there is a strong contrast here between naturally generated winds which do the same thing in the same conditions and the lawless

Typhoeus. One can also look at *Works and Days*, 663 ff., where sailing in the period of 50 days after the solstice is recommended, when the breezes are regular and the sea harmless. However, there is a big if: if Poseidon the earth-shaker and Zeus, king of the immortals want to destroy you, their actions can override the normal behaviour of the winds for the outcome of all ventures, good or bad, is in their hands. For Anaximander, winds seem to behave in a perfectly regular manner. It is also possible to bring in Homer here. In *Odyssey*, X, Aeolus, the keeper of the winds, gives a securely closed bag full of captured winds to Odysseus, so that he can sail home safely, only for Odysseus' crew to open the bag thinking it contained riches, unleashing the winds and disrupting his return journey.

There is considerable coherence to Anaximander's theory here and more generally. We have several phenomena being explained in the same way, but the notion of bursting or rupture is common to several theories. As we saw in the last chapter, we have the bursting of the spine-like barks of the Caddis flies, the rupturing associated with humans being born from fish and the bursting of the bark around the earth. Here we have the bursting of the clouds.

Is Anaximander's meteorology fruitful? I would say there are two senses in which it could be said to be so. First, Anaximenes builds on it directly, if we accept the testimony of Stobaeus. He says the same thing as Anaximander but adds an interesting observation about oars and the sea. Second, Anaximander's meteorology seems to set an agenda for many other Presocratics who give natural explanations for thunder, lightning, thunderbolts, hurricanes and typhoons, several of them taking on all five of these phenomena.

There is something else to be said here about Anaximander's meteorology if the targeting and allusions hypotheses are correct. Anaximander would seem to be the first person to target a well-known passage from the poets and to offer natural explanations. This would also seem to be very fruitful if, as I have argued, many other Presocratics are part of this pattern of allusion and targeting. Indeed, that may be rather more fruitful than the meteorology itself. What I want to emphasise here is that Anaximander's meteorology has some significant epistemic merits which have been underplayed in the literature. It is not merely an issue of giving natural explanations which ultimately were superseded.

Conclusion

One of the themes of this book is that in the debate about continuity or radical change from Homer and Hesiod to Anaximander, we should place Anaximander

more to the radical change end of the spectrum. If Anaximander alluded to Hesiod and that was part of a more general Presocratic pattern of targeting Homer and Hesiod, we have good reason to do so. It would seem that Anaximander wants to emphasise the differences between himself and Homer, especially between himself and Hesiod and to distance himself from their views. Against Cornford, it is much more than 'a very thin partition' which divides Anaximander from Hesiod.⁶⁷ There is a question as to whether Anaximander grouped these five phenomena together or that it is an artefact of the doxographers. I doubt that we can give a conclusive answer here, but I have proposed arguments to suggest that it was indeed Anaximander who began this tradition. Anaximander may well have been acquainted with folk traditions in meteorology. In terms of theory quality, there is a definite coherence to his views on meteorology. *All* of these phenomena are to be explained in terms of wind. This is a general theory of considerable scope. Is it a theory which leads to new predictions and explanations? It is and we have concrete evidence for that in Anaximenes' extension of the theory. It is certainly a theory which has explanatory breadth and depth. Meteorological phenomena are explained in terms of wind, but we also have an explanation of the origin and nature of wind. The theory also has invariance and economy, that economy relating both to the meteorology itself and how it related to other Anaximander theories.

The Extant Fragment

In the next two chapters, I want to discuss the extant fragment, the one direct quotation we have from Anaximander, the nature of the *apeiron* and the relationship between the *cosmos* and the *apeiron*. There can be no absolute compartmentalisation of these topics but this chapter deals mainly with the extant fragment and the next mainly with the *apeiron*. I start by looking at the extant fragment and its context, both the problem of the preceding sentence and the rarely addressed question of what follows immediately, with the possibility that some ancients saw affinities between the *apeiron* and Plato's receptacle. The extant fragment, with its talk of penalty and retribution, is usually understood in terms of the cycle of the seasons. Thus the domination of the hot and the dry in the summer gives way to the cold and the wet, etc. In relation to this I raise a critical question. Is this dominance global, such that there is an excess (e.g. of hot and dry) in the *cosmos*, or is it local? I argue that the dominance is local. This has some important consequences for how we see the relationship between the *cosmos* and the *apeiron*, and also some implications for the fate of the *cosmos*. I argue that the extant fragment is interesting in relation to some poets who complained of political, moral and social decay, such as Solon and Terpander, with Anaximander projecting ideal relations and ultimate stability onto his *cosmos*. It is important relative to Homer and Hesiod that Anaximander naturalises justice and sees it as something invariant, effecting another transformation of their views. It is also important that Anaximander saw the *apeiron* as part of nature or *phusis*, something which has often been denied in the literature. This has important consequences for whether steering is a part of nature or *phusis* and the extent to which it can be said to act on the *cosmos*.

The extant fragment

We have one passage from Simplicius which may preserve some of Anaximander's own words:

Τῶν δὲ ἐν καὶ κινούμενον καὶ ἄπειρον λεγόντων Ἀναξίμανδρος μὲν Πραξιάδου Μιλήσιος Θαλοῦ γενόμενος διάδοχος καὶ μαθητὴς ἀρχὴν τε καὶ στοιχεῖον εἶρηκε τῶν ὄντων τὸ ἄπειρον, πρῶτος τοῦτο τοῦνομα κομίσας τῆς ἀρχῆς. λέγει δ' αὐτὴν μήτε ὕδωρ μήτε ἄλλο τι τῶν καλουμένων εἶναι στοιχείων, ἀλλ' ἐτέραν τινὰ φύσιν ἄπειρον, ἐξ ἧς ἅπαντας γίνεσθαι τοὺς οὐρανοὺς καὶ τοὺς ἐν αὐτοῖς κόσμους· ἐξ ὧν δὲ ἡ γένεσις ἐστὶ τοῖς οὖσι, καὶ τὴν φθορὰν εἰς ταῦτα γίνεσθαι **κατὰ τὸ χρεών. διδόναι γὰρ αὐτὰ δίκην καὶ τίσιν ἀλλήλοις τῆς ἀδικίας κατὰ τὴν τοῦ χρόνου τάξιν**, ποιητικωτέροις οὕτως ὀνόμασιν αὐτὰ λέγων·

Of those who say it is one, in motion and unlimited, Anaximander, son of Praxiades of Miletus, was a follower and student of Thales. He said that the *archê* and element of existing things was the unlimited, being the first to give this name to the *archê*. He says this is not water, nor any of the other so-called elements, but some other unlimited nature, from which are generated all the heavens and the *cosmoi* in them. The source of generation for extant things is that into which destruction occurs, **according to what is necessary/proper. For they pay penalty and retribution to each other for injustices according to the ordering of time**, as he says in a poetic fashion.¹

The words in bold here are generally accepted as Anaximander's own.² Wöhrle translates (with Wöhrle's quotation marks):

„entsprechend der Notwendigkeit. Denn sie leisteten einander Recht und Strafe für die Ungerechtigkeit nach der Zeitordnung“.³

On translation and text here, *κατὰ τὸ χρεών* is interesting. It is usually translated 'according to necessity' but *χρεών* can also have another sense, of that which is 'right or proper'.⁴ Mourelatos has argued that it is important to consider the second sense in some passages in Parmenides and it is important to bear this possibility in mind here as well.⁵ How to translate here is an important decision. Necessity fits a more mechanical interpretation of Anaximander, while if steering is thought to be important, the *apeiron* may steer in a proper or appropriate manner. For the moment I leave these options open, and note that fate is also a possible translation, as 'selon le destin' or 'selon ce qui doit être'.⁶ Kahn believes that *χρεών* 'combines the ideas of right and necessity'.⁷

The important textual issue here is that Diels restored *allêlois*, to each other. This was not in some earlier editions and radically alters the meaning of the sentence.⁸ Without *allêlois* whatever is paying penalty and retribution must do so to the *apeiron*, not to each other. This would seem to indicate that the injustice they are paying for is that they came into existence in the first place. The old reading had a certain attraction, both to Christians who could then see something

like original sin and final redemption in his passage and Neoplatonists who could see emanation from and return to the first principle.⁹ Once we have *allêlois* in the text, I would agree with Kahn's blunt statement that:

There is no place, either in the wording of the fragment or in the immediate context, for any penalty or wrongdoing which could involve the Boundless.¹⁰

I would also agree with Vlastos who comments that:

If becoming were a theatre of injustice without reparation, it would not be cosmos but chaos, and the elegant pattern of balanced equalities in Anaximander's world would collapse.¹¹

So there is no injustice against the *apeiron* and consequently no reparation paid to the *apeiron*. The group of entities which commit injustice pay reparations amongst themselves.

Finally, κατὰ τὴν τοῦ χρόνου τάξιν is another interesting phrase. It is not immediately clear what this means or how it relates to the rest of the fragment. One option here is to translate *chronou* as Time, so to some extent personifying time, along with translating *taxin* as something like ordinance or assessment, so we get 'according to the assessment of Time'. As KRS say:

The word τάξις suggests the ordaining of punishment by a judge, or more aptly, the assessment of tribute as in the Athenian tribute lists.¹²

So we personify time which then acts like a judge in a court of law. Kirk, Raven and Schofield (KRS) back this with a reference to Solon, Fr. 24, 1–7:¹³

Why did I cease before I gained the objects for whose sake I brought together the people? The great mother of the Olympian deities would be my best supporting witness for this in the court of Time (Χρόνου) – black Earth, whose boundary-stones, fixed in many places, I once removed; formerly was she enslaved, now is she free.¹⁴

The aspect that KRS wish to push here is the inevitability of the retribution of Time. There is no specific period, but Time will ensure any injustice is righted eventually.¹⁵ Conche translates the fragment:¹⁶

Selon ce qui doit être; car ils se rendent justice et réparation, les uns aux autres, de leur mutuelle injustice, selon l'assignation du Temps.

The other option here, taken by the majority of commentators, is to take *taxis* in its primary sense of order or arrangement and leave *chronos* without a capital. This looks the most natural way to take the phrase, but does run into the difficulty of

exactly how time manages this ordering. It has been suggested that κατὰ τὴν τοῦ χρόνου τάξιν is peripatetic paraphrase, which is possible but certainly not necessary. I think we can make good sense of this phrase as Anaximander's original wording.

As far as we are aware, Anaximander did not use the phrase *kata phusin*, according to nature, a standard phrase in natural philosophy, usually indicating law-like behaviour. It is interesting, though, that he uses κατὰ τὸ χρεών and κατὰ τὴν τοῦ χρόνου τάξιν. Both of these phrases could be taken as indicating law-like behaviour and could be forerunners of the *kata phusin* expression.

Immediate context of the fragment

There is an issue with the sentence that precedes the extant fragment that does not come across in most English translations. 'The source of generation for extant things is that into which destruction occurs' obscures the fact that in the Greek, that out of which generation occurs and that into which things are destroyed are both plural. That might be thought to be a strange thing to say about the *apeiron*, which one might expect to be referred to in the singular. Vlastos has commented that:

The shift to the plural can mean only that in this context the Boundless is explicitly thought of as a plurality.¹⁷

The issue has then been: What sort of plurality should we suppose the *apeiron* to be? Cherniss has argued that the *apeiron* is an unlimited plurality with an infinite number of contrary pairs.¹⁸ Vlastos, who is critical of Cherniss, has a more balanced approach. He says that:

The answer is surely that Empedocles and Anaxagoras both thought of their original compound as made up of Parmenidean bits of Being, eternally self-identical in the mixture as in the world which issues from it. This is just what we cannot ascribe to Anaximander without anachronism: he thought of his Boundless as 'one' in a far more intimate sense than would have been possible for a physicist schooled in Parmenidean logic.¹⁹

One might raise questions about the consistency of Aristotle and Theophrastus in referring to the *apeiron* using a plural or a singular, as McDiarmid has done.²⁰ Aristotle uses the 'generated from, dissolved into' formula in several places, sometimes using the plural, sometimes using the singular. In the sentence before Theophrastus uses the plural, he uses the singular to refer to the *apeiron*. In some

of the doxography that almost certainly derives from Theophrastus, the singular is used. So Theophrastus is not consistent and perhaps we should not read too much into his use of the plural. This inconsistency may have been generated by oral transmission down to Theophrastus.

As Graham has pointed out, we can find something approximating to the ‘out of . . . in to’ formula relatively early in Presocratic thinking, with Xenophanes, Fr. B27:²¹

ἐκ γαίης γὰρ πάντα καὶ εἰς γῆν πάντα τελευτᾷ

All things are from earth and into earth all things die.

So while the *genesis* and *phthoran* terms are likely to be a peripatetic paraphrase, it is perfectly possible that Anaximander said something along these lines.

There is one more thing to say about the context of the extant fragment in Simplicius. That is about the sentence that follows it, which though not often discussed, is highly interesting. Simplicius tells us that:

It is clear that Anaximander, observing the change of the four elements into each other, thought it proper to make no one of these the substratum, but something else besides these.

This gives us another possible reason why Anaximander supposed the existence of the *apeiron*. We might call this the Platonic reason for supposing the *apeiron*, as Plato at *Timaeus*, 49b–d says that:

First of all, we see that which we now call ‘water’ becoming by condensation, as we believe, stones and earth; and again, this same substance, by dissolving and dilating, becoming breath and air; and air through combustion becoming fire; and conversely, fire when contracted and quenched returning back to the form of air and air once more uniting and condensing into cloud and mist; and issuing from these, when still further compressed, flowing water; and from water earth and stones again: thus we see the elements passing on to one another, as it would seem, in an unbroken circle the gift of birth. Accordingly, since no one of these ever remains identical in appearance, which of them shall a man definitely affirm to be any one particular element and no other without incurring ridicule? None such exists.²²

So a possible motivation for the *apeiron* might be that Anaximander did not see earth, water, air or fire as basic and so sought something underlying which was basic. There is no need here to read any of Plato’s account of the receptacle back into Anaximander, though it is possible that the ‘no true element’ argument had its origins with him in some form. Whether Simplicius would have made this

comment if Plato had not written the *Timaeus* is open to question. Does Simplicius' comment come straight from some information on Anaximander, or is it an interpretation influenced by Simplicius' reading of Plato? Either way, this should be borne in mind as a possible motivation for Anaximander. Does this *Timaeus* passage allude to Anaximander's position? It is interesting to see that Wöhrle prints this passage for Anaximenes but not for Anaximander!²³ I would say that there is at least as good a case for some allusion to Anaximander here.

It is interesting that both Aristotle and Simplicius associate the *apeiron* with Plato's receptacle in some manner. One important aspect of that is that if there are similarities between the *apeiron* and the receptacle, that is going to distance Anaximander from the early atomists and their ontology of an infinite void and atoms. Aristotle at *On Generation and Corruption*, II/1, 329a5–15 says that:

The *apeiron* must of necessity be light or heavy or hot or cold. What is written in the *Timaeus* is not well defined. It is not stated clearly whether the all present is separate from the elements.

I assume that Aristotle makes this point because Anaximander believes the opposite, that the *apeiron* is neither light nor heavy nor hot nor cold. Did Aristotle have sight of Anaximander's texts? It is interesting here that Aristotle jumps to 'What is written in the *Timaeus*' when one would expect something from Anaximander to support or illustrate what he has just argued. It is also significant that Aristotle pairs together Anaximander and Plato in this context, rather than Anaximander and the early atomists. Aristotle clearly sees that the *apeiron* has more in common with Plato's receptacle than with the atoms and void of Leucippus and Democritus.

I doubt that we can press this point, as Plato is far from clear in the receptacle passages and the interpretation of those passages is the subject of considerable controversy. All I want to illustrate is that there are greater similarities between Anaximander and Plato than between Anaximander and the early atomists and that some sort of similarity was recognised in antiquity. One might argue that there are indeed some important similarities between the *apeiron* and the receptacle. They both form some sort of matrix for the entities of our world and both, at least on my interpretation of Anaximander, are supposed to be as characterless as possible. If there is motion in both, it does not lead on its own to the formation of a *cosmos* but needs steering by the *apeiron* for Anaximander and the intervention of the demiurge for Plato. I have emphasised the biological aspects of the *apeiron* and the first stages of cosmogony for Anaximander, while

Plato used a father, mother and offspring analogy in relation to the receptacle. Both the receptacle and the *apeiron*, on my account, are finite but unlimited by anything exterior to them. Of course there are significant dissimilarities as well. The receptacle is said to have 'traces' of the elements in it, in a random way, while this cannot be said of the *apeiron*. The *apeiron* steers, and that steering is immanent, while in Plato the demiurge imposes forms and numbers on the receptacle. One can go on with this sort of list, but all I want to point out is that there are some important similarities between the *apeiron* and the receptacle, some of which seem to have been recognised in antiquity; our recognition of them should distance our conception of Anaximander's *apeiron* from the early atomists' conception of space. A final comment on this is that it may be the case, as KRS suggest, that Anaximander was 'very obscure about the originaive stuff'.²⁴ It may be the subject matter that is problematic here, as Plato is notoriously (and indeed, self-consciously) obscure on the receptacle and the relation of the receptacle to the things we see about us.

Alternative reading

I want to present an alternative reading of the extant fragment. First, I want to differentiate between two possibilities. Is the issue that:

- (a) there is more of one contrary in the *cosmos* than its opposite (e.g. a greater amount of hot than cold); or
- (b) there is a differential distribution of a precisely equal amount of contraries (it is hot here, but cold there).

I will call these the diachronic view (any imbalance in contrary pair generation/dissolution is corrected over time) and the synchronic view (there is never any imbalance in contrary pair generation/dissolution, balanced pairs are generated/dissolved simultaneously).

The standard example here on the diachronic view is that of the cycle of the seasons. In the summer there is a predominance of the hot, which will eventually give way to winter and the predominance of the cold or, on a shorter timescale, cold night is followed by hot day.²⁵ Thus the injustices of the contraries to each other (the predominance of hot or cold) are made good by the passing of time; the contraries, in a sense, pay retribution to each other.

However, the cycle of the seasons does not establish that there is a preponderance of one contrary over another in the *cosmos* at any time. This is

too local a view, especially for Anaximander. If it is summer in Homer, Hesiod or even Thales, where there is effectively only one side to the earth, and the sun does not pass under the earth, we might conclude that the whole *cosmos* is at this time hot. In Anaximander's model though, if it is hot day here, it is cold night on the other side of the earth; if it is hot summer here, it is cold winter on the other side of the earth. So I reject the idea that the cycle of day and night, or of the seasons, demonstrates a temporary global preponderance of contraries in Anaximander.

There is also a serious problem with the idea of an imbalance of contrary pair production/dissolution. Quite simply, where does that leave the *apeiron*? The contrary pairs are generated from or dissolved into it. If, for example, more hot than cold is generated, does that leave the *apeiron* cooler? If it does, that would seem to compromise its nature in an unacceptable manner. One reply here might be to say that the *apeiron* is infinite, so separating off a finite amount of hot will have no effect. That, though, attributes infinite magnitude to the *apeiron* and an understanding that taking a finite amount away from an infinite entity does not affect its nature.

An alternative approach would be to argue that the *apeiron* would be unaffected by a differential production of hot and cold. One might argue that there would be a problem for any mixture conception of the *apeiron*, where hot and cold are conceived of as somehow mixed in the *apeiron* and then separated out from it. The separation of more hot than cold would leave the *apeiron* colder. This, then, is a good reason for believing that the *apeiron* is not a mixture of qualities. It is that which is productive of qualities such as hot and cold but is in no way hot or cold in itself. The production of hot on its own would have no effect on the *apeiron*.

We have no direct evidence of whether or not hot and cold were generated in a balanced manner in Anaximander. Philosophically, given the assumptions of the period I think it unlikely that there would be any unbalanced production of hot and cold. Given his predilection for symmetry and sufficient reason, I also find it unlikely that Anaximander would go in for an unbalanced production of hot and cold or any other matching pair of qualities.

So let us look at the synchronic alternative, which I believe opens up some interesting lines of interpretation. We have, then, a perfect balance of contraries at all times, just a differential distribution of those contraries. So how would the standard example of the passage of the seasons work on this model? Here it is of interest and importance that Anaximander has a central stable earth with the sun and the other heavenly bodies moving around it. As the sun moves, it does not generate any more day or heat, but the distribution of day and heat changes

in co-ordination with the distribution of night and cold. There is no more hot than cold, but the distribution again changes in coordination. Other changes can be thought of along these lines as well. So if someone is drying themselves, the towel becomes wet to the extent that the body becomes dry.²⁶

Suppose that Anaximander in some way equated or identified time with the motions of the heavenly bodies, as Plato did later.²⁷ We could then understand κατὰ τὴν τοῦ χρόνου τάξιν as something like 'in accordance with the motion of the heavenly bodies' or perhaps 'in accordance with the order generated by the heavenly bodies'. Eusebius, *Preparatio Evangelica*, X, 14, 11 does tell us that:

Anaximander was a student of Thales, being the son of Praxiades and he, too, of the people of Miletus. He was first to construct a gnomon so as to distinguish the turnings of the sun, time, seasons and equinoxes. Anaximander was well known to Anaximenes, son of Eurystratus of Miletus.

Anaximander almost certainly had enough knowledge of the heavens and of the cycle of time and the seasons to identify the motions of the heavens or even, perhaps, just the motion of the sun with time. That of course is not to say that he did so, but it is an intriguing possibility. It would at least answer Graham's question:

What power and authority does time have to maintain the balance of the opposites?²⁸

Time does not have to manage the balance of the opposites in the sense of there being more hot than cold in the *cosmos* or vice versa, but if time is equated with the motions of the heavens, especially the motion of the sun, it manages the cyclical re-distribution of the contraries in the *cosmos*.²⁹

One point that should be noted here is that although the example of the cycle of the seasons occurs in many modern discussions of Anaximander, this is a modern artefact. Anaximander does not discuss the cycle of the seasons himself. It is not Anaximander's example and it may have limitations. However, treating the seasons in this way is something that is found quite commonly in antiquity. Alexander Polyhistor, speaking in relation to the Pythagoreans, tells us that:

Light and Darkness, Hot and Cold, Dry and Moist, are the things which have equal portions of the cosmos. Of these the prevalence of the Hot gives summer; of the Cold, winter; of the Dry, spring; of the Wet, autumn.³⁰

One might also note with Cornford that Empedocles says:³¹

For all these are equal and coeval; but each has its own prerogative and its own character and ways, and they prevail each in turn in the revolution of time.³²

So here we have the equality of the Empedoclean elements and the sense that each comes to prevail in turn through time. That there can be equality of the elements or contraries but that each can be in a sense dominant in turn is well attested in Presocratic thought.

Drying out

One interesting consequence of the synchronic interpretation is that the *cosmos* could not become entirely dominated by one component, such as the dry. This would rule out some theories of the death of the *cosmos* for Anaximander. Some have generalised the idea that the earth is drying to the idea that the *cosmos* will eventually dry out and be absorbed into the *apeiron*. On the synchronic theory, if the earth dries out, the moisture must go somewhere else in the *cosmos* rather than be destroyed. The *cosmos* as a whole cannot become entirely dry. There might be such a separation of the dry and the wet that it could no longer be called a *cosmos* (without absorption into the *apeiron*) but that is a different matter and no one is suggesting that for Anaximander. Engemann has suggested that we might take the relation of fiery 'bark' to moist tree in the Pseudo-Plutarch passage as indicative of the relative proportions of fire and moisture at the inception of the *cosmos*, the earth and *cosmos* then becoming progressively drier.³³ I doubt that Anaximander meant any such proportion, especially in such a loose analogy, and we would also have to take into account the intensity of the 'hot' here. I find it implausible that Anaximander's *cosmos* would contain an imbalance of opposites in totality, however they are distributed. I see no evidence in any other passage to suggest that the opposites are not separated off in a balanced manner.³⁴

Natural justice

In relation to taking κατὰ τὴν τοῦ χρόνου τάξιν as 'according to the ordering of time', with a lower case t, I would agree with Vlastos that:

We may speak of this transition, the work of Anaximander and his successors, as the naturalization of justice. Justice is no longer inscrutable moira, imposed by arbitrary forces with incalculable effect. Nor is she the goddess Dike, moral and rational enough, but frail and unreliable. She is now one with 'the ineluctable laws of nature herself'; unlike Hesiod's Dike, she could no more leave the earth than the earth could leave its place in the firmament.³⁵

My only quibble here with Vlastos is that I would use transformation rather than transition to emphasise the active role played by Anaximander in this move. Of course there are other approaches here. One can translate and have time as a god or personified. One can, with KRS, stress the inevitability of reparation with a lapse of time between injustice and reparation, and emphasise the possible legal background to *taxis* here.³⁶ That too would give a naturalisation of justice, though not in as strong a form as I have argued for here. In relation to the KRS view, I do not wish to deny that there is legal background to *taxis* or that there is an interesting poetic background to *dikê* and *chronos*, as in the passage from Solon. It may be that the extant fragment is written 'in a poetic fashion' deliberately in order to evoke or allude to such ideas. The question, then, is does Anaximander do that in order to agree with these ideas or in order to show how he transforms them? The evidence of the previous chapter in relation to Hesiod would suggest that we need to keep the latter firmly in mind. On this view, Anaximander alludes to the earlier notions of *taxis*, *dikê* and *chronos*, but transforms them into something new.

This passage, too, may be significant in relation to the poets. Theognis,³⁷ a sixth-century BCE poet, wrote:

χρήματα δ' ἀρπάζουσι βίηι, κόσμος δ' ἀπόλῳλεν,
 δασμὸς δ' οὐκέτ' ἴσος γίνεταί ἐς τὸ μέσον·

They seize property by violence; kosmos has perished
 Equitable distribution no longer obtains.³⁸

Against this decline in moral standards, where *cosmos* ought to be taken as organised society, we might see Anaximander asserting that there can be no such decline in the behaviour of the *cosmos*. One might also think of the rather unstable reciprocity that one finds in Homer here,³⁹ and compare this to the stable reciprocity projected by Anaximander.

Translating *chreôn* as right/proper rather than necessary gives a stronger moral sense to the regularities of the *cosmos* for Anaximander, especially against the background of this passage from Theognis. One can get similar considerations if there is allusion to Solon here, as Solon was noted for his dislike of a perceived decline in Athenian civil society. Anaximander transforms by imposing a stable, equitable, moral process on the *cosmos* which society can then emulate. I would agree with Graham that:

The kind of justice envisaged in the fragment is not concerned directly with civic political arrangements, but with possessions. Anaximander does not have in mind primarily a constitutional crisis, but a dispute about ownership.⁴⁰

The view I have put forward is very much one of justice among equals. There are always equal amounts of each pair of contraries (hot and cold, wet and dry) in the *cosmos*, though locally one of the pair may predominate. I note here that in Theognis, the question is not how much property but its equitable distribution. The final word on justice in Anaximander goes to Heraclitus, who said that:

εἰδέναι δὲ χρή τὸν πόλεμον ἔοντα ξυνόν, καὶ δίκην ἔριν, καὶ γινόμενα πάντα κατ' ἔριν καὶ χρεών.⁴¹

It is necessary/proper to know the war is common and justice is strife and that all things happen according to strife and necessity/what is proper.

KRS comment that:

This must be a deliberate amendment of Anaximander's dictum that things pay retribution to each other for the *injustice* of their alternate encroachments in the process of natural change.⁴²

I would agree that there is an allusion to Anaximander here; I will argue that there were other thinkers who also alluded to Anaximander. It could be argued that this passage supports κατὰ τὸ χρεών as being part of the extant fragment, as Heraclitus ends with κατ' ἔριν καὶ χρεών. For Heraclitus, strife is just in opposition to Anaximander.⁴³ Against the justice among equals view, Mansfeld has objected that:

Equality before the law is not an ancient Greek notion.⁴⁴

He cites Gagarin as saying:

The notion that Greek justice was an affair between equals, involving equal compensation for injury or some other sort of equilibrium, is simply not supported by the evidence.⁴⁵

Let us for the moment assume this to be true. The thesis here is not that Anaximander projected actual Greek ideas of justice or property relations onto the *cosmos*. Rather, it is that he projected idealised relations onto the *cosmos*. There are various parallels one might cite here. First, Anaximander would not be the only ancient Greek to project idealised values in cosmology. Plato's *Timaeus* would be a lead example here. Second, later in this book, when we come to consider the spacing of the stars, moon and sun in Anaximander's cosmology, I will argue that although there are influences from architecture and politics to be seen, Anaximander again projects idealised relations onto the *cosmos*. Finally, Heraclitus has no problem in projecting idealised property relations onto cosmology whatever the state of real property relations in ancient Greece:

All things are an equal exchange for fire and fire for all things, as property is for gold and gold is for property.⁴⁶

Vlastos and Freudenthal

Vlastos and Freudenthal have disagreed on the nature of the *apeiron* and on the extant fragment and I would like to use their disagreement to clarify my own position. Freudenthal finds three important theses in Vlastos' famous *Equality and Justice* paper:⁴⁷

1. The basic constituents of Anaximander's world are equal opposite powers balanced against one another in a dynamic equilibrium.
2. This equilibrium is strictly *inner*-worldly: it is maintained by the sole equality of the opposites and, in particular, does not involve an intervention of the Boundless.
3. Anaximander's notion of the world as a self-regulative equilibrium in which cosmic justice prevails depends on contemporary societal order subsumed under the political notion of *isonomia*.

Freudenthal believes (1) to be uncontroversial, though I would want to distinguish between (a) views where the contraries are always equally balanced and the issue is their distribution in the *cosmos*; and (b) views where the contraries do become imbalanced, however temporarily. In my view, for Anaximander it is a physical, perhaps even logical, necessity that the generation of the hot involves the generation of the cold in equal amounts.

Freudenthal believes (2) to be false. Freudenthal takes a different view of equilibrium to Vlastos and cites Hippocratic medical texts where a disturbance of the equilibrium requires the intervention of the doctor to restore good health. On this view for Anaximander, the *apeiron* must steer the *cosmos*, or as Freudenthal puts it:

The Boundless must alternately counteract the opposites, just like the physician.⁴⁸

Vlastos, however, says that:

This is never a matter of direct action by the Boundless upon the inner structure of the world, for the whole of the cosmology is delineated in terms of the interaction of the opposites themselves upon one another. The Boundless 'governs' by 'encompassing,' i.e., by safeguarding the original equality of the opposites with one another.⁴⁹

I would again distinguish between two views. If we are talking of a balance of the quantities of the contraries, I do not think this is steered by the unlimited, as it cannot be otherwise. If we are talking of the distribution of the contraries in the *cosmos*, then I remain open to persuasion. Some passages we looked at in Chapter 3 indicate that steering could control what is happening in the *cosmos* in quite a detailed manner. Vlastos, I think, would be receptive to the idea of the sun driving the changes in the *cosmos*, as one could construe that as an entirely physical driver of change, internal to the *cosmos*. However, it may be that the *apeiron* steers the sun, and there are other changes in the *cosmos* apart from the cycle of day and night and the cycle of the seasons to consider as well where the steering of the *apeiron* might be implicated.

Freudenthal believes (3) to be false. I think that Freudenthal phrases it a little strongly. I doubt that Vlastos' view depends on the political idea of *isonomia*. Vlastos' interpretation of Anaximander would be plausible and interesting without any reference to the political background. That there was such a political background merely increases the plausibility that this was, in fact, Anaximander's view. I doubt that we need anything more complex than *isonomia* here and the view that I have put forward means that the contraries will always be absolute equals.

Immanence

I disagree with both Vlastos and Freudenthal about immanence and metaphysics. This essentially comes down to an important point about the *apeiron* and its relation to the *cosmos*.⁵⁰ Vlastos praises Anaximander for what he sees as the:

Philosophical concept of nature as a self-regulative equilibrium, whose order was strictly immanent, guaranteed through the fixed proportions of its main constituents.⁵¹

By this, Vlastos means that the *cosmos* governs itself (order is strictly immanent). Freudenthal, however, says that:

Anaximander's physical theory – the theory of the opposites – which (in a modified form) was to be embraced by Aristotle and the Peripatetic school, could not found the notion of a self-regulative, immanent, natural order. Consequently, in Anaximander as well as in Aristotelian philosophy of nature, natural order had to be sustained and upheld by external factors: in particular, what was to become the sublunary world was not a closed system. As long

as the theory of the opposites prevailed, physics could not do without metaphysics.⁵²

The *apeiron* steers the *cosmos*. The key question here is whether or not the *apeiron* is part of nature. If it is not, then for order to be immanent it must be restricted to the *cosmos*. If the *cosmos* exhausts *phusis*, then the steering principle is metaphysical. I fundamentally disagree with Vlastos and Freudenthal on this point. We have no reason to suppose that the *apeiron* is not part of nature, part of *phusis* for Anaximander. On the latter point, the Greek concept of *phusis* included the starting point and the development of the current state of things, so we would need a strong argument to establish that the *apeiron* was not part of *phusis* for Anaximander. So the steering principle is immanent in nature, even if it is not in the *cosmos*.⁵³ Vlastos' terminology is a little unfortunate here, as the alternative to immanent would appear to be transcendent, and the steering principle is certainly not that. The steering principle is part of *phusis*, so in this sense it is not metaphysical. It may not be physical in the sense that the hot and the cold are taken to be by Freudenthal, but can still be taken to be a natural entity. I can see why, both historically and philosophically, Vlastos wishes to restrict the role of steering and have order immanent to the *cosmos*, not least because of the issue of the naturalisation of justice. The naturalisation of justice point make sense if we have steering and the *apeiron* is part of nature. The *apeiron/cosmos* system works as a self-regulative entity where order and physical justice are immanent and are not dependent on the caprice of some god. Of course one can have something extrinsic maintaining the order of a *cosmos*. Freudenthal cites the active intellect of medieval Aristotelianism,⁵⁴ one might also cite Isaac Newton, that the solar system would degenerate into chaos if it were not for the active intervention of God. It is not necessary that there is extrinsic control though and for Anaximander there is a very good case that the *apeiron* is part of *phusis* and that nothing extrinsic is required.

Hesiod

This discussion of Anaximander's extant fragment and the *apeiron* is worth placing in the context of Hesiod. If the extant fragment does refer to the sequence of day and night and the sequence of the seasons, then it forms a stark contrast with Hesiod, notably *Works and Days* where the cycle of the seasons is driven by the gods. A simple example here is that at *Works and Days*, 415–16 it is Zeus who

begins the autumn rain. On the issue of justice, *Works and Days*, 258 ff. has Zeus' immortal watchers of mortal men, wandering on earth, taking note of judgements and watching over wrongdoing. Vlastos' point about the naturalisation of justice in Anaximander is even stronger against this background. *Works and Days* also has the advice that the 50 days after solstice are best for sailing and sailors are unlikely to be shipwrecked, unless Poseidon, the earth shaker or Zeus, king of the immortals, wishes to destroy them. The outcome of all things good or bad is in their hands. The term *taxis* does not occur in Hesiod, but the term *dietaxis* occurs twice. *Theogony*, 74–5 has Zeus destroying Kronos by force, and then says:

εὖ δὲ ἕκαστα ἀθανάτοισι διέταξε νόμους καὶ ἐπέφραδε τιμὰς.

He has appointed their ordinances to the immortals, well in each detail, and assigned them their privileges.⁵⁵

While *Works and Days*, 277 runs:

τόνδε γὰρ ἀνθρώποισι νόμον διέταξε Κρονίων.⁵⁶

This was the rule for men that Kronos' son laid down.

Here I am using West's translation of Hesiod. It is interesting that West says of Anaximander that he:

Explained certain cosmic changes in terms of 'injustice', 'retribution', 'ordinance', language which Simplicius calls 'rather poetic' (DK12B1) but which it is much more meaningful to classify as theological.⁵⁷

Did West have *Theogony*, 74–5 in mind when translating *taxin* as 'ordinance' in the extant fragment? Did Anaximander have that in mind when he wrote it? How many of his readers would have seen this as an echo or an allusion? If so, is this another example of transformation by Anaximander, in that *taxis* is not generated by a god and is not merely for humans, but is for the whole *cosmos*?

Conclusion

I have argued that the contraries pay reparation to each other, not to the *apeiron*, but the injustice is the unequal distribution of equal amounts of the contraries in the *cosmos*, rather than the temporary production of a greater amount of one contrary. Indeed, the production of more of one contrary has serious and often unacceptable implications for the nature of the *apeiron*. It is important here to think about whether we are considering local changes or changes at the level of

the *cosmos* for Anaximander. It is possible to produce a good reading of the extant fragment on this view. We also get a good sense for the ‘according to the order of time’ phrase, especially if we take the sun as generating night and day and the seasons as being associated with time. As Vlastos has put it, this also gives a strong take on the naturalisation of justice. The idea that the elements/contraries remain in quantitative balance while one of them may be said to in some sense dominate is well attested in Presocratic thought and may originate with Anaximander. One important implication is that while the earth may to some extent dry out, with the moisture moving elsewhere in the *cosmos*, the *cosmos* cannot itself dry out. It is important to bear in mind that κατὰ τὸ χρεών can mean ‘according to what is right/proper’ as well as ‘according to necessity’. Using ‘necessity’ here fits well with a mechanical interpretation of Anaximander, but ‘right/proper’ is perfectly possible as a translation here, gives a stronger moral sense to Anaximander and allows for the *apeiron* to steer in a moral manner. Both *apeiron* and *cosmos* are part of *phusis* for Anaximander. Steering is a process immanent in *phusis*. We cannot marginalise it by considering it to be metaphysical, transcendent or something which affects that *apeiron* but does not affect what we term ‘nature’.

The *Apeiron*

Anaximander's *apeiron* remains an enigmatic entity.¹ It is not even clear how we should translate this term. Infinite? Unlimited? Boundless? Indeterminate? Untraversable? In what follows on etymology and meaning I suggest that unlimited is probably the best translation, though that, to a large extent, still leaves open the issue of what the *apeiron* actually is. Some commentators believe it to be spatially infinite; even those who shy away from using the term infinite usually say that the *apeiron* is endless, inexhaustible or something similar. Here I want to raise two issues. First, is our concern with the external limits of the *apeiron* anachronistic? Is this something Anaximander was primarily concerned with? Second, I raise the possibility that there are senses in which the *apeiron* might be considered to be finite but unlimited. I believe there is evidence from Plato and Aristotle, on a central and stable earth, which suggests that they thought the *apeiron* was finite but unlimited for Anaximander. It is also important here to investigate what might have motivated a pre-Parmenides thinker to postulate something which was infinite in extent. I argue that there are at least as many grounds for Anaximander to have thought in terms of unlimited but finite as for him to have supposed something infinite. I also discuss the temporal nature of the *apeiron*, in particular what it might mean to say that time surrounds the *cosmos* in a parallel manner to the *apeiron* surrounding the *cosmos* spatially. The spatial and temporal nature of the *apeiron* is interesting in itself, but also has consequences for the debate about coexistent/successive *cosmoi* in Anaximander.

Anaximander's *apeiron* is considered to be 'the divine' by Aristotle. In the second part of this chapter I examine the nature of this attribution. I argue that it is perfectly possible for the *apeiron* to be entirely natural, invariant and divine and that there is no question of intervention from any god. Here I build on the idea that the *apeiron* is part of *phusis* for Anaximander. I examine whether it is proper to call Anaximander a pantheist and argue that his pantheism is not vacuous and serves an important explanatory role, in contrast to critiques of modern pantheism. I argue that it is improper to make a separation of science

and religion in Anaximander and there should be no question of trying to rank which is the more important for him.

Etymology of *apeiron*

Exactly how *apeiron* should be translated has been a matter of contention. Here I have opted for the Liddle, Scott and Jones (LSJ) view on the etymology that *apeiron* derives from *peirar*, *peras*, limit, so with the alpha-privative we have 'unlimited'.² Kahn, on the other hand, looking at usage in Homer and Hesiod, has argued that *apeiron* is derived from *perainein*, to pass over, so that:

The true sense of *apeiros* is therefore 'what cannot be passed over or traversed from end to end'.³

In my view unlimited gives a reasonable sense to Homer's usage. Kahn has argued that Homer uses *apeiron* of the earth and sea, which do have limits, but I doubt we can hold a poet to literal and technical uses in such circumstances. Homer's use of *apeiron* here may attempt to evoke an emotional sense of unlimited while knowing quite well earth and sea have physical limits.⁴ From the emotional perspective of a traveller, or even Homer's audience earth and sea may feel unlimited. Kahn cites uses of *apeiron* for circles and rings.⁵ There is a very good sense in which a circle or a ring is unlimited, in that, unlike a finite straight line, one can go around the circumference without limit. Kahn also cites uses of *apeiron* in relation to nets where one is 'entangled past escape', but again a poet might use *apeiron* here to evoke an emotional sense of a net without limit from which one cannot escape.⁶

More recently, Couprie has revived Tannery's idea that *apeiros* is derived from *peira*, so the meaning would be 'that which cannot be experienced'.⁷ That would have a reasonable sense, as the *apeiron* would be physically inexperienceable (being beyond our *cosmos*) and quite probably in principle inexperienceable if it is not an element like water or air and is not qualified by being hot or cold, etc. Semerano has suggested the semitic '*apar*', the Hebrew '*afar*' and the Akkadian *eperu*, all meaning 'earth'.⁸ This would, in a sense, complete a presocratic quartet (Thales water, Anaximenes air, Heraclitus fire, now Anaximander earth) with the sense that everything comes from and returns to earth.⁹ However, if this is the case, then it is remarkable that there is no sense of *apeiron* being taken in this manner (for Anaximander or anyone else) in Presocratic thought.

Meaning of *apeiron*

There have been four main proposals for the meaning of *apeiron* in Anaximander. These are the indeterminate, the infinite, the untraversable and the unlimited (or boundless, or unbounded). The motivation behind taking *apeiron* to mean indeterminate is that while Thales and Anaximenes are specific and determinate, citing water and air respectively, Anaximander is not. There are certain situations where it may be informative to say that the *apeiron* is indeterminate in relation to other things, in that it does not have the determinate characteristics of, say, water or air, or even of hot or cold. It is another step, though, to say that the *apeiron* is indeterminate in all aspects or that *apeiron* means indeterminate.¹⁰ In fact, several studies have shown that *apeiron* never means indeterminate.¹¹ Also telling against this view is that if Anaximander did want a term that indicated indeterminateness, there were better ones available.¹² A further issue here is that the *apeiron* does have some specific, determinate characteristics. It is unaging, undying, it surrounds all, it steers all, and it is the divine.¹³

To say that *apeiron* means 'infinite' is a very strong assertion which almost certainly imports a later and more technical sense to *apeiron*. There are later Presocratic discussions which do invoke a fully fledged sense of the infinite (infinite space, Leucippus and Democritus, infinite division, Anaxagoras, Zeno). Earlier use in Homer and others clearly does not. Anaximander could, of course, be the first to take *apeiron* to mean infinite but that would be a supposition and it is difficult to see his motivation for doing so. Cicero does use the term *infinitatem naturae* in relation to Anaximander, at Cicero, *Academia*, II, 37, 118:

Firstly Thales, one of the seven, to whom the other six conceded primacy, said that all things were water. However, Anaximander, his countryman and friend, was not persuaded; he said there was an infinite nature (*infinitatem naturae*) from which all things were generated.

However, this does not help us much, as *infinitas* in Latin has a much broader meaning than our own infinity. Lewis and Short give 'not limited, infinite, endless, boundless, unlimited'.

Kahn, as we have seen, has proposed untraversable for *apeiron*. The idea that something is untraversable can be ambiguous. Is it impossible to traverse because it is infinite? Or is it impossible to traverse because it is too large, without being infinite, for humans to traverse? The latter sense is important relative to poetic usage, as Homer might well talk of untraversable sea or land, meaning humans could not traverse them while not believing either to be infinite. So one might

imagine the *apeiron* to be something which, while it has limits and so is neither infinite or unlimited, is large enough to be untraversable for humans.

One concern I have with Kahn's account of *apeiron* is that untraversable very rapidly slips into infinite.¹⁴ Kahn says that the notion of untraversable quickly passes into that of immense or enormous and that *apeiron* has a strong spatial sense in some Presocratic fragments.¹⁵ Kahn also says that in later philosophical usage, *apeiron* is contrasted with *peras* (limit) and *peperasmenon* (end) in such a way that *apeiron* meant infinite in these contexts. That is true, but it does not establish how Anaximander used the term. According to Kahn, Anaximander's *apeiron* is a 'huge, inexhaustible mass, stretching away endlessly in every direction'.¹⁶ Given Kahn's view on the etymology of *apeiron*, huge is fair enough here, but inexhaustible and stretching away endlessly are less justified. We then come to Kahn's conclusion that:

The boundless is in fact what we call infinite space, the antecedent of the atomistic void as well as for the Receptacle or Nurse of generation in Plato's *Timaeus*. But this space is not yet thought of in abstraction from the material which fills it. Place and body are here combined in a single idea.¹⁷

So, untraversable has become infinite and Anaximander is an antecedent to the atomists. There is a tension which needs to be addressed here though, as Plato's receptacle and the atomist's infinite space are not compatible ideas. There are, as we saw, some interesting similarities between Anaximander's *apeiron* and the receptacle of Plato's *Timaeus*. However, the receptacle for Plato is most definitely not infinite in extent, though one might well argue that it is unlimited, at least in the sense that there is nothing external which constrains it. With Anaximander's *apeiron* we do not have a distinction between space and material. That seems to me to be a very good reason for not treating it as an antecedent to the atomist void, with its radical bifurcation of existence and non-existence and its assertion of the existence of the void. This leaves us with unlimited (or unbounded) for the translation of *apeiron* in Anaximander. This is my preferred translation as etymologically best and also the most flexible translation. It leaves open issues of the nature of the *apeiron* and also leaves open the extent of the *apeiron* in both space and time.

More recently, Couprie and Kocandrlé have argued that it is not clear that Anaximander ever used *to apeiron*, the unlimited, employing a neuter article and with *apeiron* as a substantive.¹⁸ There is evidence that he used *apeirôs* or *apeiron* as an adjective, qualifying something else. They cite Aristotle, *Physics*, 203b3 ff., where Aristotle contrasts Plato and the Pythagoreans, who made the unlimited

something which existed in itself, with 'all those concerned with nature' who make some other nature the subject to which unlimited is predicated. There are various strategies which we might pursue here. One might accept this passage applies to, say Anaximenes, but be concerned whether Aristotle had Anaximander in mind, though both Alexander and Simplicius thought he did.¹⁹ However, Aristotle's references like 'all those concerned with nature' are by no means precise and consistently all inclusive,²⁰ while Alexander and Simplicius can only be surmising (and not always correctly) that this applies to Anaximander. Against that, there are, as Couprie and Kocandrle show, a significant number of passages in the doxography which fit with the idea of *apeiros* being used to qualify something else and are not easy to explain away.²¹ They propose the very interesting idea that what Anaximander spoke of was not *to apeiron*, but a *phusis apeiros*, an unlimited nature.²² This they understand as 'the boundless, inexhaustible power that generates all things and makes them move and grow'.²³ Couprie and Kocandrle state that:

On all occasions where Aristotle mentions Anaximander by name, it can be convincingly argued that nowhere Anaximander is connected directly with τὸ ἄπειρον and that there is evidence that he included him in the group that made ἄπειρος the attribute of something else.²⁴

This is an interesting strategy, though I am not convinced that we can rule out all instances where Aristotle does not mention Anaximander by name and there is some connection with *to apeiron*.²⁵ Rather, I would recognise that there is confusion in our sources from Aristotle onwards. This may well reflect confusion concerning whether Anaximander thought the *apeiron* to be other than the elements or something intermediate between two elements,²⁶ whether the *apeiron* is some form of mixture.²⁷ It may reflect Aristotle's hostility towards the *apeiron* (it cannot exist).²⁸ It may reflect that Anaximander either said nothing definite about the *apeiron*,²⁹ or nothing definite enough came down to Aristotle; all this may reflect an oral transmission of Anaximander's work. This perhaps did not transmit enough about the *apeiron* or perhaps did so in a confused or garbled manner. So we may not be able to recover whether Anaximander spoke of 'the unlimited' or of 'the unlimited something'. While this is of course an important metaphysical question, the difference between my view and the Couprie/Kocandrle view is less than might be supposed. In my view, if Anaximander spoke of *to apeiron*, this had determinate characteristics (capable of steering, divine, etc.) and was biological in its nature (the source from which the *cosmos* grows in an organic manner). I would note two important differences

in approach between Couprie/Kocandrle and myself though. First, I believe we can make sense of *to apeiron*, though not as an inexhaustible reservoir or as an unlimited stuff if that stuff is characterless and passive.³⁰ Second, I am less concerned than Couprie/Kocandrle with generating a narrative whereby Thales is corrected by Anaximander is corrected by Anaximenes.³¹

Central earth?

Heath comments that:

A spherical Infinite is in itself a gross and glaring contradiction, which we should not attribute to Anaximander without direct evidence.³²

I would agree, with some qualifications, but I want to raise another possibility here: that the *apeiron* is unlimited but spatially finite.³³ That would fit well with early usage of *apeiros*, used to describe rings where there is a clear sense in which a ring is unlimited but finite. One piece of evidence in favour of this view is that later thinkers tell us that Anaximander had the earth in the centre, with the implication that Anaximander must have then held that the universe was finite. There are two passages which suggest this. There is the well known passage from Aristotle, *On the Heavens*, II/13, 295b11–15 (DK12A26):

There are some, such as Anaximander among the ancients, who say that (the earth) rests on account of its likeness. It is no more fitting that what is established in the centre and has equal relations to the extremes should move up, down or to the side. It is not possible for it to move in opposite directions at the same time, and so necessarily it remains still.

There is some debate about whether Anaximander did, in fact, give an indifference argument for the stability of the earth, which I will look at later. My view is that the alternatives are unworkable and there is very good evidence that Anaximander gave an indifference argument. The important matter for us here though is that Aristotle believed that for Anaximander the earth is in the centre and ‘has equal relations to the extremes’. The most straightforward reading here is that Aristotle is thinking in terms of a finite spherical universe for Anaximander with the earth at its centre. At this point the argument that an infinite space can have no centre was well known.³⁴ If Anaximander has put the earth in the centre of an infinite space, we would not get this sort of report from Aristotle.

One reply here would be to question whether the earth is in the centre of the universe or is in the centre of a *cosmos*. If the latter, then there might be many

cosmoi in an infinite *apeiron*. I think the evidence is rather against this possibility. I would expect to see more indication that such a remarkable thesis was in play and some more criticism of such a thesis from Aristotle. Aristotle says that the earth has 'equal relations to the extremes'. The word I have translated as 'extremes' here is *eschata*, which when used spatially is usually rendered farthest, uttermost or extreme and generally has a sense of utmost or last. It is then plausible that the reference is to the extremes of space rather than the extremes of a *cosmos*.

There is another way to support this view, which although is in some ways speculative, is also interesting. This involves Plato, *Phaedo*, 108e–109a7, which says that:

I am now persuaded that, firstly, if (the earth) is round and in the centre of the heavens, then it requires neither air to prevent it falling nor any other necessitation of this sort, but the uniformity of the heaven itself in every way and the equipoise of the earth itself is sufficient to restrain it. For something which is equipoised and is placed in the middle of something homogenous cannot yield to being moved aside in any way, but in like manner will remain steadfast.

My view of this passage is that it is a report of Anaximander's view.³⁵ Again, we have the earth in the centre at a time when the argument that the infinite has no centre is well known. If this is Plato's report of Anaximander's position, then there is no question that Plato attributes a finite universe to Anaximander. Plato was vitriolically opposed to the early atomists and the ideas of an infinite void and infinite *cosmoi*. In the *Philebus*, he says that:

The infinite plurality of things and in things makes you in each case indefinite of thought and someone of neither status nor account, since you have never yet examined the number in anything.³⁶

Plato simply did not make positive comments on anyone who believed in infinite space. In the *Phaedo*, he is critical of those who use a vortex to hold the earth in place, or those who have it ride on air like a lid, but singles out whoever held the indifference argument and agrees with them. If this is a report of Anaximander's position, then Anaximander did not believe in infinite extension of the *apeiron*.

Unlimited but finite?

The suggestion is, then, that Anaximander's *apeiron* is spatially finite but unlimited. It would be spherical in shape, as is implied by the passages in Plato and Aristotle,

but generalised to three dimensions and a sphere. One might also invoke another sense of unlimited here, which is that the *apeiron* is all that there is (along with the *cosmos* it generates) so that it is not limited by anything else. It cannot be spatially limited because there is nothing else which is spatial. It can also be thought of as unlimited or unbounded because there is nothing which limits it or forms a boundary for it, even if it is finite. So *contra* Seligman, a finite *apeiron* does not entail 'a solid dome, the egg-shell all over again'.³⁷

If Anaximander did think of the *apeiron* as unlimited but finite, that makes an interesting contrast with the views of Homer and Hesiod, who could well be said to have limits to their worlds and whose worlds were not spheres. The emphasis in Hesiod is that there is a heaven above the earth and Tartarus below the earth. A bronze anvil dropped from heaven travels nine days and reaches the earth on the tenth; if dropped from the earth travels nine days and reaches Tartarus on the tenth. In this way there is a strong directional sense to Hesiod's world and also a strong sense of limit. With Homer there is not quite such a sense of a linear world with a direction of fall, but there are limits in the sense of sky and the pillars which support the sky: Homer's world is not spherical.

Motivation for the infinite?

Given the various possibilities for understanding *apeiron*, what would be Anaximander's motivation for supposing the *apeiron* to be spatially infinite? We also ought to consider what might have motivated Anaximander towards the idea of the finite but unlimited. This inverts the usual process of looking for reasons that Anaximander would have believed in something infinite.³⁸ One argument here places Anaximander in context with Thales and Anaximenes. Thales says the substance out of which everything is generated and into which everything is destroyed is water; Anaximenes says that it is air. What sort of answer, then, is the *apeiron* in this context? If the primary emphasis or meaning is that it is spatially infinite, then this looks virtually a *non sequitur* (what is it?, there is an infinite amount of it). A better sense for *apeiron* in this context is internally unbounded. That might have two senses. The *apeiron* is not bounded in the sense that it is not a determinate element like water or air. Alternatively, it may have no internal boundaries; it is homogenous and does not have a particulate nature.³⁹ It may be that the emphasis placed on the external limits of the *cosmos* in Anaximander by commentators both ancient and modern is anachronistic. Yes, the external limits are an interesting and important issue for us and were an

important issue in ancient cosmology for some thinkers after Anaximander. This does not demonstrate that this was a key issue for Anaximander. Certainly I would like to see more argument rather than assumption that external rather than internal bounds are what Anaximander had in mind.

I raise the possibility that Anaximander said nothing definite about the external limits of the *apeiron* and was not particularly concerned by the issue. In my experience of studying early cosmological/cosmogonical texts, issues that we find critical are simply not important to those who wrote the text. So in Babylonian cosmology, the issue of how the earth is supported is simply not addressed. In the Bible, there are passages which favour *ex nihilo* creation but do not rule out creation from unformed matter, and passages which favour creation from unformed matter but do not rule out creation *ex nihilo*. There are no passages favouring *ex nihilo* or unformed matter which rule out the alternative. Why? At the time the Bible was written, this was not a significant issue, even if it was later to become so for the early Christians down to Augustine.⁴⁰

On other motivations, one cannot cite any direct influence, as Anaximander is supposed to be the first to postulate infinite space. He is pre-Parmenides and pre-Zeno, so this cannot be a response to Eleatic issues about plurality, change or sufficient reason.⁴¹ It has been suggested that Anaximander required an infinite *apeiron* in order that generation should not eventually cease, but given that what comes out of the *apeiron* is recycled, this does not seem necessary. Drozdek has suggested that in relation to infinity:

The roots of this thought are theological in nature. When philosophers started to think about the nature of the divine in order to rectify it from popular anthropomorphic accretions and free it from behaviour the epic gods were supposed to have, the infinity came as one attribute constituting the divine.⁴²

First, let us assume that one can derive the notion of infinite time from the life span of the epic gods. It is not immediately clear why one would then consider space to be infinite. The Greek gods of Homer and Hesiod live in a finite world, with finite sizes and specific locations, unlike one view of the Christian god who is infinite and is everywhere. Second, it is not immediately clear that the idea of infinite time does derive from the epic gods in a straightforward manner. Yes, the epic gods are described as undying and unageing. However, there is a need to differentiate between two senses of 'immortal' here. There is the immortality of Tolkien's elves. They are born, they do not suffer either from old age or sickness, but they can be killed. Alternatively, there is the immortality of the Christian god, who has always existed and will always exist. I would suggest that the Greek

epic gods are rather closer to the first conception of immortality here. It is less evident how an idea of genuinely infinite time could be generated from the lifespan of such creatures.

A different counter-argument here is to cite possible sources for the idea of unlimited but finite in Anaximander. First, there is the use of *apeiros* in relation to rings.⁴³ It is interesting in relation to the ideas of a finite but unbounded *apeiron* and an internally undivided *apeiron* that plain rings were described as *apeiros*, while rings which had an inset gem were not.⁴⁴ Later in this book I will go into some detail about the influences on Anaximander's cosmology. One possibility is political, with the symmetry and the centred, circular arrangement of the *cosmos* mirroring the new political arrangement of the *polis*.⁴⁵ Whether we talk of political or geographical space though, the space outside the *polis* may, in some sense, be unlimited (not politically determinate as the *polis* is) but it is not infinite in extent. The adoption of money has been cited as an influence but, again, while there may be a good sense that money is unlimited it is not infinite in extent.⁴⁶ Architectural theory and practice may have been influential, but again while in contrast to a building the architectural space around it may be unlimited, it is not infinite in extent.

It is also worth questioning modern motivation for attributing the idea of infinite space to Anaximander. Out of historical generosity, it might be good to see him as the first person to employ the notion of infinite space. If we see Leucippus and Democritus as the early standard bearers of science and generously want to see Anaximander as a precursor to them, we might also wish to grant Anaximander infinite space. However does the evidence really justify that and is that generous to Anaximander, given his argument about the centrality and stability of the earth?

Temporally unlimited?

Is the *apeiron* temporally unlimited? That is probably not built into the meaning of *apeiron* for Anaximander, as in early usage *apeiron* can mean spatially unlimited but not temporally unlimited. However, it seems clear that the *apeiron* does not have any temporal limits. The key descriptions here are that Aristotle describes the *apeiron* as *athanaton* and *anôlethron*, immortal and indestructible (Aristotle, *Physics*, III/4, 203b6, DK12A15), while Hippolytus describes the *apeiron* as *aidion* and *agêrô*, undying and unageing (Hippolytus, *Refutation of All Heresies*, I, 6, 1, DK12A11). That, along with the general tenor of Aristotle's

remarks, establishes the *apeiron* as temporally unlimited, at least in the sense that it has no beginning and no end and is not limited by anything else.

Does the *apeiron* temporally surround the *cosmos*?⁴⁷ That is an intriguing possibility, either in tandem with the *apeiron* spatially surrounding the *cosmos* or independent from it. The surrounding could not be exactly parallel, as the *apeiron* could only frame the *cosmos* at either end rather than surround it two or three dimensions, but that still gives a reasonable sense to surrounding. As Mansfeld has pointed out, Aristotle does use *periechein* and its cognates for the length of life of creatures and for the temporal nature of the heavens.⁴⁸ Mansfeld also says that:

A cosmological interpretation of the Anaximander fragment allowing for the disappearing of the world-system(s) becomes quite plausible once the verb περιέχειν is taken in a temporal sense as well.⁴⁹

That is a very interesting idea, though I think it needs to be pushed a little further. If time surrounds the *cosmos* or *cosmoi*, then there is time before and after it. So there will be a first *cosmos* and there will be a last *cosmos*. This significantly distances Anaximander from the early atomists for whom there is no first *cosmos*. If there is time after the *cosmos*, that might be thought to support the successive *cosmoi* theory. However, we come up against similar problems, at least for any theory of infinite successive *cosmoi*. If there is time before any *cosmos*, there is a first *cosmos*; if there is time after the *cosmos*, there is a last *cosmos*. Neither will fit the infinite recurring *cosmoi* theory: this would significantly distance Anaximander from Empedocles. Time surrounding the *cosmos* would support the idea of a single *cosmos* which comes into existence and then goes out of existence. It might also support the idea of a single *cosmos* which comes into existence and could go out of existence, but has not yet.

Why does this debate about the temporal and spatial characteristics of the *apeiron* matter? There has been considerable debate about whether Anaximander believed in a unique *cosmos*, multiple co-existent *cosmoi* or successive *cosmoi*. Some ideas about space sit well with this view, others do not. Less often recognised but equally important is the fact that ideas about time sit well with the successive *cosmoi* view while others do not.

Anaximander and the divine

The leading objection to Anaximander being a natural philosopher is that he may have believed the *apeiron* to be the divine. This is the key passage from Aristotle:

Τοῦ δὲ ἀπείρου οὐκ ἔστιν ἀρχή ... οὐ ταύτης ἀρχή, ἀλλ' αὕτη τῶν ἄλλων εἶναι δοκεῖ καὶ περιέχειν ἅπαντα καὶ πάντα κυβερνᾶν, ὥς φασιν ὅσοι μὴ ποιοῦσι παρὰ τὸ ἀπειρον ἄλλας αἰτίας οἷον νοῦν ἢ φιλίαν. Καὶ τοῦτ' εἶναι τὸ θεῖον· ἀθάνατον γὰρ καὶ ἀνώλεθρον, ὥς φησιν ὁ Αναξίμανδρος καὶ οἱ πλείστοι τῶν φυσιολόγων.

The unlimited has no *archê* ... However, this seems to be the *archê* of all other things, and it surrounds all and steers all, as with all those who do not suppose other explanations, such as mind or love, beyond the unlimited. This is the divine, for it is immortal and unaging, as Anaximander and most of the physiologoi say.⁵⁰

Anaximander is then supposed to have believed in something divine and therefore, in some accounts, to have believed in something non-natural. Let us look a little more closely at the passage though. First, let us note that there is an article here, τὸ θεῖον, such that the translation should be 'the divine' not just 'divine'.⁵¹ There is an ambiguity here, so let us proceed carefully. Anaximander and most of the physiologoi say that something is 'immortal and unaging'. For Anaximander, this has to be the *apeiron* which 'surrounds and steers.' Does Aristotle say that Anaximander believed the *apeiron* to be the divine, or is it Aristotle's own inference that the *apeiron* is the divine because it is immortal and unaging?⁵² It would be no great surprise if Aristotle moved from 'immortal and unaging' to saying 'the divine' even if Anaximander did not say so himself. I am not sure we can resolve this ambiguity, though if Anaximander did consider the *apeiron* to be the divine, I don't think that matters too much.

The only other evidence we have on the divine in Anaximander is Augustine, *City of God*, VIII, 2:⁵³

His successor was Anaximander, his pupil, who had another view of the nature of things. According to him, things were not generated from one substance, as Thales believed they were from water, but each from its own individual principles. These principles of singular things he believed to be infinite, and to generate infinite worlds and whatever happens in them, and those worlds he believed are now dissolved, now generated once more, in accordance with the age each is capable of surviving, nor did he give the divine mind any role in the working of things. Anaximander left behind as his disciple and successor Anaximenes.

There are many reasons to be suspicious of the evidence here though. Augustine is a late source and has a clear Christian agenda. He seems to have assimilated Anaximander to the early atomists and with Leucippus and Democritus the divine mind does not have any role in the working of things. On this issue, we can safely discard Augustine's evidence.

Divine and natural?

Should we be concerned if Anaximander did consider the *apeiron* to be the divine? Is it possible to have a belief in something which is both divine and entirely natural? Christian theology, where it argues for a transcendent god which is separate from nature and which can override the laws of nature, would seem to exclude this. This tradition has had a powerful influence on our intuitions such that the idea of a natural god may seem a somewhat strange one. Given the conception of the Gods in Homer and Hesiod, it may have been a strange idea for the Presocratic Greeks as well.

The *apeiron* though does not stand outside of nature, but is that from which the elements of the *cosmos* come and that into which the elements of the *cosmos* will be dissolved. For Anaximander, all this occurs according to natural law. From the extant fragment, that is going to be true of the relations between the *apeiron* and what is generated from it/dissolved into it as well as the ordinary functioning of the *cosmos*. There is no question, then, that the *apeiron* obeys natural laws. It matters little, then, if Anaximander did describe the *apeiron* as divine. There is no intervention in nature from something outside of nature.

If we think about this in the terminology of early Greek philosophy, then we need to think in terms of *phusis*. This, if anything, makes Anaximander's conception of what is more holistic and unitary. The *apeiron* is clearly part of *phusis*, but the organic nature of *phusis* allows for the growth of the elements of the *cosmos* from the *apeiron* in an easy manner. Again, from the extant fragment it should be clear that *phusis* obeys laws. So if Anaximander did equate the *apeiron* with the divine, everything is still natural for Anaximander, or put another way everything is part of *phusis*. So I would disagree with Jaeger's comment that:

Anaximander's explanation of nature is something more than mere explanation of nature: it is the first philosophical theodicy. In this so-called philosophy of nature we have thus found theology, theogony, and theodicy functioning side by side.⁵⁴

Anaximander has a fully fledged philosophy of and explanation of nature. There is nothing above or beyond nature here and nothing which does not obey natural laws. If considering the *apeiron* to be the divine amounts to a theology, then it is an entirely natural theology. There is no theogony here. If the *apeiron* is the divine, and we are equating that in some way with god, then this god does not

come into existence. There is no theodicy here. That anachronistically imposes Christian or at least Platonic worries which are alien to Anaximander. If what Jaeger has in mind here are the physical injustices rather than human injustices, then there may be a natural theodicy if the *apeiron* steers the process which generates cyclical changes such as day/night, the seasons or the weather cycle, but that is an entirely natural process.

Intervention?

Homer and Hesiod have gods who have wills. Anaximander has something which he considers to be divine, which steers all things. Can we really speak of the naturalism of Anaximander and contrast that with Homer and Hesiod? Is there really so much difference? The key issue in my view is invariance. There is a distinction between the capricious, unpredictable nature of the gods of Homer and Hesiod and the regular manner in which the *apeiron* steers for Anaximander. There is a distinction between the way in which the gods of Homer and Hesiod can intervene in nature, breaching regularities, and the way in which the *apeiron* effectively underpins the regularity of nature for Anaximander. Homer and Hesiod were, of course, aware of regularities in nature,⁵⁵ but their gods were capricious. So, meteorological phenomena were not part of the regular order of nature, but due to the capricious will of Zeus the cloud gatherer or Poseidon the earth shaker. The gods were also capable of intervening in human affairs and in the regularities of nature. The idea of nature as invariant, that there is a regular order to it, is then a major move from the picture of Homer and Hesiod.

It has rightly been questioned whether the notion of intervention in nature is a modern one and is inappropriate for the ancient Greeks.⁵⁶ It is certainly inappropriate for Milesian pantheism, as the divine is not separate from nature, so can hardly intervene in it in the modern sense. There is a perfectly reasonable way in which the gods of Homer and Hesiod can be said to intervene in nature. They are capable of breaching the regularities of nature where other entities are not. Explanation in terms of the gods in Homer and Hesiod is not just a question of 'there is lightning and we explain that as being due to Zeus'. The gods, from their own caprice, actively create phenomena. So Zeus generates lightning to blast ships for his own purposes: the plague at the beginning of the *Iliad* is due to his being offended by Agamemnon. In this sense they are capable of intervening in nature.

Pantheism

That Anaximander, and indeed the other Milesians, advocated some form of pantheism is now widely accepted.⁵⁷ Vlastos has commented that:

In Ionian philosophy the divine is nature itself, its basic stuff and ruling principle. To say that the soul is divine is then to naturalize it; it is to say that it is subject to the same sequence of law and effect which are manifest throughout the whole of nature. And this is the very opposite of the Orphic doctrine of the divinity of the soul, whose content is rather obscure, but whose intent is perfectly clear: that the soul is not a natural, but a super-natural, entity.⁵⁸

Given that pantheism is a relatively modern term and that modern pantheists generally see Spinoza as their philosophical founder,⁵⁹ is that an appropriate term for a Presocratic thinker? The term was first made popular by Toland in 1705,⁶⁰ although it was first used in 1697.⁶¹ I think we may reasonably use the term for some Presocratics and it is possible to be more precise about Anaximander's type of pantheism.

Within pantheism there is an issue concerning identity. Usually some form of identity between god and the universe is asserted, but there can be differences here. More esoteric pantheism denies any strict logical identity between god and the universe. The classical philosophical position, though, is that of Spinoza, who asserted that god and the universe are the same substance. That seems appropriate to Anaximander, who I take to be saying that the *apeiron*, that which does the steering and that which is divine, are one and the same thing, even if we might have reservations about calling the *apeiron* a substance. I take Anaximander to be a material pantheist, in distinction to the nineteenth-century German tradition of pantheism, which was idealist. Anaximander is not asserting that the material is one aspect of the ideas which exist in the mind of god. I take Anaximander to be a collective pantheist, in the sense that he believed the universe as a whole to be divine. The alternative, distributive pantheism, where each individual entity is thought to be divine, might be a better description of Thales. Aristotle tells us that:

Thales supposed the soul to be capable of generating motion, as he said that the magnet has soul because it moves iron.⁶²

Aristotle goes on to say:

Some believe soul pervades the whole *cosmos*, and perhaps this is the source of Thales' view that everything is full of gods.⁶³

There is a case for calling Anaximander a panpsychist, based on the evidence of Plato in the *Philebus*, that *nous* and a marvellous organising intelligence steer the *cosmos*.⁶⁴ However, as we have seen, Plato may have his own agenda for supposing that there is some form of intelligence or mind behind the steering. Panpsychism would probably be a good term for Anaximenes.⁶⁵ The most accurate term for Anaximander's views is possibly 'pankubernist', that is, someone who believes that everything steers. I strongly disagree with those who see pantheism as a disguised form of atheism, at least in the ancient world. Dawkins has commented that:

Pantheism is sexed-up Atheism.⁶⁶

I believe this to be false for the ancient world and that is important generally for the Presocratics and for Anaximander in particular. Partly this depends on what the pantheism consists of. I take a key part of the pantheism to be the steering effect. I have argued that the steering principle is critical to Anaximander's account of cosmogony. It is because there is steering that the *cosmos* can have so much *taxis*. Without steering, or some similar principle, the order of the *cosmos* would be unexplained, or there would be a need for a multiple co-existent *cosmoi* view. It is important to note here that Leucippus and Democritus were, in effect, atheists. Anaximander's pantheism is substantial. It is not merely the vacuous application of 'divine' to the universe, but involves steering and an explanation of the origins of order in the *cosmos*, an explanation that could not be had by an atheist in this context. I would reject as entirely unsubstantiated the idea that Anaximander was really an atheist who hid his atheism under a veil of pantheism to avoid criticism or even prosecution. If Xenophanes could criticise Homer and Hesiod for shameful theft, adultery and deceiving each other,⁶⁷ then there must then have been a considerable degree of freedom to express views on matters of religion.

While some construction using pan-, whether it be pantheism, pandeism or pankubernism describes Anaximander reasonably well, there is one further point to address here. Does this description technically apply to Anaximander? The issue here is that it is the *apeiron* which surrounds all and steers all, and the *apeiron* which is the divine. What then of the *cosmos*? Clearly, that does not surround, but is it not divine? Does it do no steering? If so, technically the pan-attribution to Anaximander would be incorrect. Clearly, one issue here is how different the *cosmos* or its constituents are from the *apeiron*. Whatever the answer to that, I would still suggest that using pan- remains a good first-order description of Anaximander. This may need some revision when we take into account the relationship between the *apeiron* and the *cosmos*.

Science and 'the divine'

There is an older debate on theology in Anaximander. Burnet argued there was 'no trace of theological speculation' in Anaximander,⁶⁸ supported by Matson.⁶⁹ Jaeger on the other hand argued that 'theology, theogony and theodicy' sat side-by-side in Anaximander's account of nature,⁷⁰ supported by Burch.⁷¹ Jaeger commented that:

What happens in Anaximander's argument (and that of his successors in line) is that the predicate God, or rather the Divine, is transformed from the traditional deities to the first principle of Being (at which they arrived by rational investigations), on the ground that the predicates usually attributed to the gods of Homer and Hesiod are inherent in that principle to a higher degree or can be assigned to it with greater certainty.⁷²

This debate was conducted in terms of the old conflict model of the relation of science and religion. This historiography has undergone a significant transformation in recent years. The thesis, that religion and science are always in conflict, is now seen as outmoded; it has been superseded by a complexity thesis⁷³ in which religion may promote science, be neutral to it or in conflict with it, depending on specific circumstances.⁷⁴ This is important for Anaximander, as we need not be forced into a polarity where religious beliefs conflict with a belief in natural explanation (or vice versa), forcing us to question whether the belief is genuine or the commitment to natural explanation. There is no need to argue, then, that where we find a commitment to natural explanation, any expression of a belief in god must be a matter of convention, to avoid religious prosecution and that behind this lies atheism or secularism. A consequence of the move away from the conflict historiography is that we need not try to separate the 'religious' and 'scientific' aspects of Anaximander's thought.⁷⁵ In relation to this, I would disagree with Drozdek, who says that:

Physics for Anaximander is secondary to theology – it is used to substantiate theology; physics becomes an afterthought of sorts that is used to make his physics less otherworldly.⁷⁶

I do not want to argue that theology is secondary to physics for Anaximander, rather I reject the separation and the ordering of supposed scientific and religious aspects of Anaximander's thought here.⁷⁷ I would agree with Babut though that:

Anaximandre transforme profondément le concept du divin, détaché d'un seul coup de toute référence humaine.⁷⁸

Conclusion

I have suggested here that the *apeiron*, in spatial terms, may be unlimited but finite. I believe that to be plausible in terms of the etymology of *apeiros*, and its early use in the description of rings. If the earth is in the centre and stays there by indifference for Anaximander, as the evidence of Aristotle and Plato suggests, then it must be at the centre of something finite. If the *apeiron* surrounds the *cosmos* in temporal terms, that would suggest that the *cosmos*, or any succession of *cosmoi* also have a finite amount of time, either individually or collectively. These conceptions of space and time, as we shall see, have implications for the debate about the number of worlds in Anaximander.

Ultimately, the nature of the *apeiron* remains enigmatic. Partly, no doubt, that is due to the paucity of concrete evidence we possess, though it may be due to the nature of such theories. Both Aristotle and Simplicius associated the *apeiron* with Plato's receptacle in some aspects. That is important in that it distances the *apeiron* from early atomist conceptions of space and matter. It may also be significant in that Plato also found the relation between the receptacle and the things we see in our world to be hard to express.

It may well be that Anaximander did refer to the *apeiron* as 'the divine', but it remains lawlike and part of nature or *phusis*. There is no intervention from any god – in sharp contrast with Homer and Hesiod. There is no need to separate the supposed religious and scientific elements of Anaximander and set them against each other or rank them. Anaximander is best seen as advocating a form of pantheism, though a pantheism that is substantial.

Cosmogony and Steering

We do not have a great deal on the specifics of cosmogony for Anaximander, though we have more than with Thales, so it can be reasonably claimed that Anaximander is the first extant cosmogony we have in the Greek philosophical tradition. The outlines of that cosmogony are reasonably clear. There is a separation of opposites such as hot and cold out of the *apeiron*, a sphere of flame forms around the earth, the stars separate out from the flame and the earth takes form under the heating influence of the sun. The details are less clear and have been contested. One issue I will be particularly concerned with in this chapter is that of steering. First, I want to argue that we can definitely attribute steering to Anaximander. Second, I want to look at how steering was used by other early Presocratics to establish that it was used in relation to cosmogony. I then want to look at the relation between cosmogony, steering and *taxis*, arguing that an important possibility is that it is steering which gives Anaximander's *cosmos taxis*. In some accounts of Anaximander's cosmogony, both ancient and modern, steering has been downplayed or even ignored. A counterpart of the idea that steering has an important role in cosmogony is that there are no vortices for Anaximander, so cosmogony was not initiated in the manner of the early atomists or Anaxagoras. The supposed evidence in Aristotle does not, in fact, attribute vortices to Anaximander. The nature of the eternal motion of the *apeiron* is also important here. I argue that it is improper to suppose that the *apeiron* was particulate, especially in a pre-Parmenidean thinker; this, too, undermines the idea of vortices. This is important for the nature of the *apeiron*, but has two further consequences. First, there has been a debate about whether cosmogony is essentially mechanical or biological for Anaximander. Eliminating vortices considerably helps the biological case. Second, there are implications for the debate on whether there were co-existent *cosmoi* in Anaximander. Eliminating vortices and some conceptions of the eternal motion pushes strongly in the favour of a single *cosmos*. Finally, in this chapter I want to look at the relationship between the cosmogonies of Anaximander and Hesiod. This has been a contested

area. Some suggest that there are considerable similarities between the two, others that there is a radical difference and that Anaximander, in some ways, represents a new way of thinking about the nature of cosmogony.

The Cosmogony process

The first part of cosmogony for Anaximander is the generation of opposites like hot and cold from the *apeiron*. I will begin with what Aristotle says here, as he is our earliest source and he uses slightly different terminology from later sources. He says:

Οἱ δ' ἐκ τοῦ ἐνὸς ἐνούσας τὰς ἐναντιότητας ἐκκρίνεσθαι, ὥσπερ Ἀναξίμανδρός φησι καὶ ὅσοι δ' ἐν καὶ πολλά φασιν εἶναι, ὥσπερ Ἐμπεδοκλῆς καὶ Ἀναξαγόρας· ἐκ τοῦ μείγματος γὰρ καὶ οὗτοι ἐκκρίνουσι τᾶλλα.

There are those for whom the contraries are in the one and are separated out of it, as Anaximander says, along with those who say that the one is many, such as Empedocles and Anaxagoras. They too produce the other things from the mixture by separation.¹

Aristotle uses ἐκκρίνεσθαι and ἐκκρίνουσι for the emergence of the opposites. The verb *enkrinein* can mean simply to separate out,² but it can also mean to secrete, in the sense that living things secrete.³ If we adopt the latter option here, we have a rather more organic sense of the *apeiron* and its functions. The verb *apokrinein*, found in the doxography derived from Theophrastus, does mean to set apart or to separate without the organic sense of secretion. A possible line of argument here is that Aristotle, being our earliest source, had the correct verb. As I have argued earlier though, we cannot assume that Aristotle had access to Anaximander's written work and the different verbs here may reflect oral transmission. Our choice here is underdetermined and one can only point out that *enkrinein* goes better with a biological reading of Anaximander while *apokrinein* goes better with a more mechanical reading. Pseudo-Plutarch gives us something more specifically cosmogonical:

He says that which is productive of the hot and cold was separated at the genesis of this *cosmos*, and that a sphere of flame was formed around the air around the earth like the bark around a tree. When this was broken off and enclosed in certain circles, the sun, moon and stars were formed ... The stars were generated as circles of fire, separated off from cosmic fire, surrounded by air.⁴

Here we have a *gonimos*, 'something productive of the hot and cold'. The term *gonimos* can also have organic connotations, meaning 'productive', 'fertile' or 'fruitful'. As this term is not much used before Aristotle,⁵ it is unlikely that it is a term Anaximander used, though that is still possible. That Pseudo-Plutarch goes on here to give a biological analogue, 'a sphere of flame was formed around the air around the earth like the bark around a tree', might indicate that something organic is meant here.

The *gonimos* has been the subject of some widely varied interpretations. Cornford has argued for association with the Orphic cosmogonical egg.⁶ I am very doubtful about that, as in Anaximander the *gonimos* is produced directly from the *apeiron*; it has a part in the generation of opposites and ultimately the *cosmos*. What we lack here are typical Orphic precursors to the egg (e.g. Chronos, Aether and Chaos) and the typical Orphic successors to the egg (e.g. gods).⁷ If some sense of fertile reproduction is meant here, it seems more likely that plant reproduction and a seed might be a better analogue. A view which I would suggest here is *periechein*, which is used of the *apeiron*. It can have the sense of a seed case; here we have the seed itself from which the *cosmos* will grow in an organic manner.

Vlastos has suggested that the *gonimos* might be better thought of as a process rather than as a thing,⁸ and the process is that of a vortex.⁹ Stokes has been critical here,¹⁰ arguing that it is unclear how a process can be separated out from the *apeiron*, something with which I would concur. I would also agree with Stokes that Democritus, Fr. 167 is not a sufficient parallel. With the context from Simplicius, this runs:

When Democritus says that 'A vortex of all shapes is separated off from the all' (how or by what cause he does not say), it appears that this occurs spontaneously or by chance.¹¹

So not merely a process is separated from the all, but shapes (the atoms) are separated. I argue below against the idea of a vortex. It is also the case that spontaneity and chance are no part of Anaximander's thought.

The steering principle

So far we have seen the processes by which a part of the *apeiron* is converted into a *cosmos*. Why should this separation from the *apeiron* produce a *cosmos*, something well ordered, rather than any other configuration? Aristotle tells us that the *apeiron*:

περιέχειν ἅπαντα καὶ πάντα κυβερνᾶν.

Surrounds all and steers all.

I take Aristotle's Greek here to be indicative that Anaximander did indeed have a steering principle.¹² Some translations can obscure the double 'all' structure here by giving 'surrounds and steers all' when the double 'all' structure may be very significant.¹³ This does not strike me as the sort of phrase that Aristotle, with his terse style of expression, would make up for himself. I would also agree with Babut that this is not a word that Aristotle would readily use for a Presocratic unless he was quoting them.¹⁴ Whether it is a direct quote of Anaximander we cannot be certain, but the repeated 'all' is interesting here, especially in relation to some early poetry. Terpander,¹⁵ Fragment 2 runs:

Ζεῦ πάντων ἀρχά, πάντων ἀγῆτωρ.

Zeus is *archê* of all, leader of all.

So one important possibility here is that Anaximander picks up on the double 'all' structure in Terpander but typically transfers the functions of a god to the *apeiron*, in a similar manner to saying that the *apeiron* 'is immortal and indestructible', typical poetic epithets for the gods. Aristotle then gives us the double 'all' structure, possibly in a slightly garbled form, quite possible if the transmission was oral.

Kubernêin means simply to steer, as in to steer a boat, or more metaphorically, to guide or govern.¹⁶ The latter may be important in suggesting some form of intelligent guidance. Certainly that would seem to be the case in Plato, who in the *Politicus* refers to god as the helmsman of the *cosmos*. The setting is the myth of the *Politicus*, which contrasts the *cosmos* under the guidance of this helmsman god against the gradual deterioration into chaos when god releases control of the *cosmos*. So we find:

When the time of all these things came to an end and change was to occur, and all of the earth born race had been used up, each soul having given back all of its births, each having fallen into the earth as seed the prescribed number of times, the helmsman (*kubernêtês*) of the universe let go the rudder.¹⁷

The myth continues, emphasising god's role as orderer and helmsman of the *cosmos*:

When the world nurtures within itself living things under the guidance of the helmsman (*kubernêtou*), it produces little evil and much good. However, when it becomes separated from him, it fares best during the time immediately after the

release, but as time proceeds and it grows forgetful, the old condition of disorder gains sway more and more, and towards the conclusion of time little good and much of its opposite flourishes, and there is danger of the destruction of the world and those in it. At this moment God, the orderer of the world, perceives that it is in trouble, and being concerned that it should not be storm driven by confusion and broken up into an endless sea of unlikeness, he takes his old place at the rudder, and reverses the sickness and destruction of the first period when the world moved itself, and he orders and sets it right again, forming it deathless and ageless.¹⁸

Of course, this does not establish that Anaximander used *kubernēin* and its cognates in a similar manner, but it at least raises the possibility that steering had an important cosmogonic role to play for Anaximander; it also had an important ongoing role in the functioning of the *cosmos*. It is very much worth noting the final two words here, ‘*athanaton*’ and ‘*agêrôn*’, ‘deathless’ and ‘ageless’, relative to similar uses in relation to Anaximander’s *apeiron*.

Furley has suggested that steering may occur once and once only, setting the *cosmos* on a course which it then follows.¹⁹ Although that is a possibility, I see no evidence to support it. In the Aristotle passage, the unlimited presumably surrounds the *cosmos* at all times rather than just at an initial moment, but no distinction is drawn between surrounding and steering in this respect. It is also worth noting that in the Aristotle passage *kubernan* is present tense, indicating an ongoing process, rather than some construction indicating a past action that is now complete, or a present action which is complete. So too Plato, *Philebus*, 28d uses *diakubernan* again in the present tense.

Nor do any of the other passages concerning steering among the Presocratics suggest that this is an on-off, rather than a persistent factor in the *cosmos*. Plato criticised Anaxagoras for postulating a cosmic intelligence which withdraws after initially ordering the *cosmos*. Had any of the Milesians had a similar theory, we might expect to see similar criticism of it somewhere in the record. We saw in Chapter 2 that Plato spoke of the *cosmos* and ‘that *nous* and a marvellous organising intelligence steer (*diakubernan*) it’.²⁰ Slightly later in the *Philebus*, he says that:

This supports those of old who believed that *nous* always rules the universe.²¹

This is significant in that it cannot be Anaxagoras that Plato is referring to here. Plato is critical of Anaxagoras for allowing *nous* to withdraw from the *cosmos*, while these men of old have *nous* always ruling the *cosmos*. It is also significant that there is no mention of *kubernēin* or any of its cognates in Anaxagoras. It is

unclear on the available evidence what the precise nature of the steering function is in Anaximander or what it steers for. A reasonable supposition though would be that it steers the separation process so that a *cosmos* rather than a chaos is formed out of the unlimited.

Is it a concern that we have only one mention of Anaximander and steering in Aristotle and no mention in any of the subsequent doxography? There are several replies here. First we have considerable evidence of steering in Presocratics other than Anaximander, such as Heraclitus, the Hippocratic authors, Parmenides and Diogenes of Apollonia, and arguably something similar in Anaximenes and the Derveni Papyrus. Steering is given an important cosmogonic role and/or an important role in the upkeep of an orderly *cosmos* in all of these thinkers. The phrase ‘surrounds all and steers all’ is not Aristotle’s style of Greek and probably echoes something Anaximander wrote. Aristotle does not value steering very highly, so it does not figure strongly either in his accounts of Anaximander or other Presocratics.²² Given this, it is then not surprising that steering does not figure strongly in the doxography derived from Aristotle and Theophrastus. We have Plato’s evidence from the *Philebus*.²³ Note the plural here (as some of those who came before us said) and that again steering has a cosmogonic role and a role in the upkeep of the *cosmos*. Anaximander has to be a prime candidate for one of the people that Plato is referring to here. Finally, the tendency to assimilation with the early atomists in the doxography would mean the marginalisation of an idea like steering.

Presocratic steering

Anaximander was not alone in supposing some form of steering principle. Heraclitus, Parmenides, the Hippocratics and Diogenes of Apollonia all make use of a steering function. I argue below that Anaximenes does as well, in addition to Thales. Heraclitus, Fr. 41 and 64 are:

All things are steered (ἐκυβέπνησε) through all.²⁴

The thunderbolt steers (οἰακίζει) all things.²⁵

As Heraclitus did not have a cosmogony, the steering here must be ongoing.²⁶ The key passage for Heraclitus’ views on cosmogony is fragment 30:

This *cosmos*, the same for all,²⁷ was not made by Gods or men, but has always existed and will always exist. It is an everliving fire, kindling in measures and going out in measures.²⁸

The standard view here is that Heraclitus is expressing the invariance and law-like behaviour of the *cosmos*. The interesting association is then steering with this law-like behaviour, whether we understand that as 'All things are steered through all' or more specifically that fire does the steering as might be indicated by Fr. 64. With Fr. 64, according to LSJ *oiakizein* means to 'steer: hence, govern, guide, manage'. Thus it seems to have roughly the same sorts of meaning as *kubernēin*. There is also a very interesting use of *kubernēin* in the Hippocratic corpus. *On Regimen*, I/10 tells us that:

In a word, everything was arranged (*diakosmēsato*)²⁹ in the body by fire, in a manner suitable to itself ... The hottest and strongest fire, which controls (*epikrateitai*) all things, manages everything according to nature (*kata phusin*), it is imperceptible to sight or touch. In this are soul, mind, understanding, growth, change, diminution, separation, sleep, waking. This steers all things through all (*panta dia pantos kuberna*) both here and there and is never still.³⁰

This would very strongly suggest that steering has both an important role in cosmogony and that steering is an ongoing process for this Hippocratic author. The fire which does the steering also does the arranging and is never still. It is also significant here that fire does all this *kata phusin*, according to nature, so there is no sense that steering is being imposed upon nature. Finally, it is also significant that the Hippocratic author speaks of fire controlling (*epikrateitai*) all things in the same context as fire steering all things. The word for control or power here, *kratein*, also appears alongside *kubernēin* in other places.³¹ Another important example is Diogenes of Apollonia, who says that:

In my view that which has intelligence is called air by men, and all men are steered (*kubernasthia*) by this and it has a power (*kratein*) over all things. This seems to be a God to me and to have permeated everywhere, to arrange (*diatithenai*) all things and to be in all things.³²

Again we have *kubernēin*, again we have *kratein*, though this time for air rather than fire. Again this air has the ability to arrange and there is no sense that it ceases to act having done the arranging. Also we have *diatithenai* meaning 'to arrange in its proper place', or 'to manage well', significant because it links the steering principle to the cosmogonical process of arranging everything in the first place, and continuing to have it well arranged. It is also significant that Diogenes links steering with intelligence. If that is the case, then there is no need for the current *cosmos* to deteriorate or to perish. There is a further use of *kubernēin* in Parmenides, who says that:

The narrower rings are full of unmixed fire, those close by are full of night but with some measure of flame. In the middle of this there is a goddess, who steers (*kubernai*) all things, ruling the hateful birth and mixture of all things, sending female to have sex with male, and conversely male with female.³³

I am hesitant to say much about Parmenides' usage here as this comes from the opinion part of the poem, the interpretation of which is extremely contentious and unclear. All I will say is that Parmenides does use *kubernein* and in a manner which indicates an ongoing process. In doing so, it may well be that he has in mind some form of critique of those who have used *kubernein* before him, so it is difficult to tell what Parmenides' attitude to steering is. I have argued elsewhere that there are also a number of Presocratics who use *kratein* and its cognates in a similar manner to these uses of *kubernein*.³⁴

One reason for looking at all this evidence is we have so little on Anaximander's use of steering. One thing to avoid would be using steering as a panacea in Anaximander, where for any unexplained phenomenon we simply say 'steering'. So, for example, we know that eclipses are caused by blockages to the holes in the rings of the moon and sun, but not why or how that happens. We might be tempted to say steering. It is good, then, to have a sense of what other early Greek thinkers thought of steering; clearly, for some, it had an important cosmogonic role.

Cosmogony and taxis

In relation to the idea of the *apeiron* steering, it is interesting to note that Diogenes Laertius, in his *Lives of the Philosophers*, 2, 1–2 tells us that for Anaximander:

μέσῃν τε τὴν γῆν κείσθαι, κέντρον τάξιν ἐπέχουσιν, οὖσαν σφαιροειδῇ.

The earth lies in the middle, having a post in the centre, being spherical.

My interest here is in the term *taxis*, for which LSJ give 'order or disposition of an army, post or place in the line of battle, generally, arrangement, order, regularity. Metaphorically; post, rank, position, station'. One way of taking this sentence is that the earth is not merely in the middle, but has been placed in the middle by something generating the order of the *cosmos*. The centre is the right place for the earth and something has intentionally put it there. How much reliance we can place on Diogenes' wording here is, of course, open to doubt. However, there can be no doubt that *taxis* was part of Anaximander's vocabulary,

as it occurs in the only extant fragment we have of his own work. As we saw, the idea of *taxis* also plays an important role in the extant fragment. All I want to establish here is that there is a solid precedent for Anaximander using *taxis*. We might also look again at Plato, *Philebus*, 28d, where ‘*nous* and a marvellous organising (*suntattousan*) intelligence’ steer the *cosmos*.³⁵ This time I want to pick out *suntattousan* from this passage, with LSJ giving ‘put in order together, esp. as a military term, draw up, put in array’. Plato would give a very strong sense of teleological ordering to *suntassein* here.

The deflationary view here would be that this reads too much into the meaning of *taxis*, which can simply mean place instead of carrying a sense of teleological ordering. So Pseudo-Plutarch says:

Concerning the order of the stars.

...

Anaximander, Metordorus of Chios and Krates placed the sun highest of all, after this the moon, then the fixed stars and planets.³⁶

Here *taxis* is arguably just used in the sense of the sequences of the stars and has no sense of teleological order. It is used of both Anaximander and of Metrodorus, a follower of Leucippus and Democritus who would reject any of the teleological connotations. Whether ultimately we can read a great deal into Anaximander’s use of *taxis* and its use in relation to him in the doxographical tradition, it is at least worth being aware of the view which would say that *taxis* indicates a strong sense of order and teleological ordering in Anaximander. That, of course, would fit very well with the idea that the *apeiron* steers the generation of the *cosmos*. The notion of *taxis* for Anaximander, along with the notion of steering, is often played down in accounts which give Anaximander multiple *cosmoi*.

Vortices in the apeiron?

Was there a vortex or were there vortices in the *apeiron*? This issue is important for cosmogony and the relation of Anaximander to other Presocratics. If there was a vortex this could be the origin of the *cosmos* as in Anaxagoras, if there were vortices this could be the origin of *cosmoi* as with Leucippus and Democritus. The evidence for a vortex in Anaximander is supposed to be found at Aristotle, *On the Heavens*, II/13, 295a7 ff.:

If the earth now remains in place by force, it was also assembled in the centre by being carried there because of a vortex. For this is the reason which everyone

gives, through what occurs in water and around air. In these the larger and heavier things are always carried to the centre of the vortex. So all those who say that the heavens are generated have the earth being assembled in the middle.³⁷

However, it is by no means clear that Aristotle includes Anaximander here. Aristotle recognised that Anaximander did not use force to explain why the earth does not move, but gave an indifference argument instead.³⁸ There is no reason to suppose that Anaximander is being referred to here.

Aristotle may also be talking rather loosely here. Certainly it is the case that some Presocratic thinkers (Anaxagoras, Leucippus and Democritus) did indeed believe that the earth is held in place by force and is assembled there by the action of a vortex. However, is this true for all those who believed the earth to be held in place by force and heavens to be generated? This would include Thales, for instance. Aristotle recognised that for Thales the earth floats on water.³⁹ For Aristotle, floating on water involves forces.⁴⁰ For Thales, the heavens are generated. So according to this passage, Thales then believed in a vortex? We have no evidence independent of this interpretation that Thales believed in a cosmic vortex.⁴¹

Anaximander has no need of a vortex. There is an indifference theory for the stability of the earth, so there is no need for a vortex to hold it in place. Simplicius, *De Caelo*, 374, 32 ff. tells us that:

Some say that a physical mechanism keeps the sky from falling, namely the action of a vortex which holds it up since the downward pull on the heavens is less than the force exerted by the vortex. Empedocles and Anaxagoras say this.

One can see why a vortex is necessary for Anaxagoras as the heavenly bodies for him are heated stones, which would fall to earth if they were not supported by a vortex. However, the heavenly bodies for Anaximander have a core of fire and a surrounding coating of compressed air: there is no reason why these should fall to earth. If the *apeiron* steers all things there is no need for a vortex to initiate cosmogony – this would itself be in need of explanation. Others who employ a vortex do give an explanation of why it begins (chance, according to Leucippus and Democritus, mind according to Anaxagoras) but we have neither chance nor mind as explanatory categories in Anaximander; there is no mention of a vortex let alone any explanation of why one would form.

If the equilibrium argument for the stability of the earth in Plato's *Phaedo* is a report of Anaximander's view,⁴² that is significant as *Phaedo*, 99b6–8 tells us of those who support the earth by means of a vortex and those who support it with air, in distinction to the equilibrium position. So in Plato's view, Anaximander did not employ a vortex. The vortex was a well-known idea with a well-defined

term, *dinê*. If Anaximander did employ a vortex, then with the doxographers often keen to assimilate his views to that of the atomists, it is very surprising there is no mention of it. If *to gonimon* was a vortex, it is odd that is not referred to at any point or the known term *dinê* used instead.

Let us assume that the heavens in Anaximander move in a circular manner. West argues that: 'Such a system patently resembles a vortex.'⁴³ However, that the heavens have circular motion does not entail the existence of a vortex. Plato and Aristotle are two obvious contrary cases. There are several references in the doxography to an eternal motion of the *apeiron*. None of them make clear the nature of that motion. Simplicius, *Commentary on Aristotle's Physics*, 24, 13, tells us that Anaximander:

Produces coming to be not through alteration of the element, but through the separating off of opposites through the eternal motion.⁴⁴

Hippolytus, *Refutation of All Heresies*, I, 6, 1–7, also says that Anaximander:

Says that the *archê* and element of all existing things is the unlimited, being the first to call it by the name *archê*. Further, there is eternal motion in this and subsequently the heavens are generated.⁴⁵

West associates the formation of vortices with random motion, as we find in Leucippus and Democritus. So he says that for Anaximander there is an eternal motion, and that:

This motion probably consists of random currents running in no fixed direction. From time to time they result in a vortex which lasts for a while and then slows down and disappears.⁴⁶

This, though, is pure supposition. We have no evidence on the nature of the eternal motion in or of the *apeiron*. The evidence in favour of Anaximander using a vortex is small and highly dubious. He had no need of a vortex and the doxographers make no mention of it. The simple conclusion here is that Anaximander never used a vortex. We have no evidence that Anaximander associated circular motion with the unlimited, and Aristotle's complaint is that Anaximander does not specify a natural motion.

Eternal motion?

There is something more to be said about the supposed eternal motion in the *apeiron* and the possibility of vortices in Anaximander. There is a very important

distinction to be made between Anaximander on the one hand and thinkers like Empedocles and Anaxagoras on the other, to do with homogeneity, mixture and parts. With Empedocles, there is a period, with the total ascendancy of Love, when the four elements are mixed perfectly. The sphere which is generated in this period could be said, in one sense, to be homogenous. The mixture of elements in any one part of the sphere will match the mixture of elements in any other part of the sphere. However, there is still a mixture and the elements still retain their own identities. As we can identify this part as earth and this other part as water, the sphere is not homogenous. One can say something similar about Anaxagoras. The initial state for Anaxagoras could in a sense be called homogenous, in that the mixture in any one part of the initial state will match the mixture in any other part of the initial state.

The point I wish to make in distinction with Empedocles and Anaxagoras is that Anaximander's *apeiron*, prior to the beginning of *cosmos* formation, is partless, homogenous and is not a mixture. A point which bears repeating here is that Anaximander is a pre-Parmenidean thinker. Anaximander does not need to think of change in terms of the redistribution of changeless parts of matter, but can have the qualities being generated out of the *apeiron*. As Vlastos has commented, we must:

Guard against reading into Anaximander atomic physics or Parmenidean logic.⁴⁷

Without atoms or other particles of matter, the atomist cosmogony based on vortices is simply not applicable to Anaximander. Diogenes Laertius, IX, 31 tells us that:

Leucippus holds that the whole is infinite ... part of it is full, and part void ... from these innumerable *cosmoi* come to be and are dissolved into these again. The *cosmoi* are generated in this manner. By 'cutting off from the infinite' many bodies of all shapes move into a great void, where they are crowded together and produce a single vortex, where colliding with each other and circulating in all manner of ways, they separate out like to like.

It is not possible, in the partless *apeiron*, for many bodies are varying shapes to come together in a vortex. A second aspect of this is that for the atomists the vortex sorts like to like. Sextus Empiricus, *Against the Mathematicians*, VII, 116–18 tells us that:

There is an old view which, as I said previously, has long been prevalent among the *phusikoi*, that like recognises like. Democritus confirmed of this opinion and Plato spoke of it in his *Timaeus*. Democritus founds his argument on both

animate and inanimate things. For animals, he says, flock with animals of the same kind – doves with doves, cranes with cranes, and so with the other irrational animals. Similarly in the case of inanimate things, as can be seen from seeds that are being winnowed and from pebbles on the sea-shore. For in the one case the whirling of the sieve separately arranges lentils with lentils, barley with barley, wheat with wheat; and in the other case, by the motion of the waves, oval pebbles are pushed into the same place as oval pebbles, and round pebbles as round as pebbles, as though the similarity in things has some sort of ability for leading things together. That is Democritus' view.

A like-to-like principle is an integral part of atomist thought, but cannot apply to the *apeiron* as there are not a diversity of like objects to be sorted in this manner. There is also no mention of a like-to-like principle in relation to Anaximander. It would seem then that there cannot be motion in the *apeiron*. That leaves us with two possibilities: that there is motion of the *apeiron* as a whole or that the attribution of eternal motion is incorrect. It is unlikely that the *apeiron* shakes in the manner of Plato's receptacle – it has no imbalance within it which would cause it to shake. If the *apeiron* is either infinite in extension, or unlimited but finite, translational motion is ruled out as there would be nowhere for the *apeiron* to go. That leaves the possibility of circular motion. This is possible, as long as we understand that such circular motion would not constitute a vortex in the orthodox sense, as there would be no sorting of the contents of the *apeiron*.

Another point to be factored in here is that the *apeiron* has a steering function. That, on its own, should rule out any random motion. The steering may mean that there is a perpetual motion of the *apeiron*; this may initiate and guide the cosmogonical process, which may be why an eternal motion is cited in this context in the doxographical reports. An alternative is that the attribution of eternal motion to Anaximander's *apeiron* is part of an assimilation of Anaximander's thought to early atomist ideas on the part of the doxographers.

One reason why this discussion of vortices and eternal motion in Anaximander is important is that, as Conche has put it, we can have an 'interprétation mécaniste' or an 'interprétation vitaliste'.⁴⁸ With the mechanical interpretation, we have eternal random motion, the generation of a vortex or vortices and the mechanical generation of the *cosmos*. Apart from the specific objections I have raised here, one must also worry that such an approach assimilates Anaximander too closely to the early atomists and ignores any significant role for steering. With the vitalist interpretation, the *apeiron* is capable of steered self-motion and of organically generating a *cosmos*.

First cosmogony?

I believe the best term for Anaximander is philosophical cosmogony. I would distinguish this from modern scientific cosmogony because it is predominantly empirical. Theories are now constrained by empirical data in a way that would have been unimaginable even in the first half of the twentieth century when precise observations began to inform and shape theories in cosmogony.⁴⁹ Having said that, philosophical issues are still to be resolved for modern cosmogony and while ancient Greek cosmogony was predominantly a philosophical activity, observations were used to support cosmogonical theories.

I would also distinguish philosophical cosmogony from creation myths and theogonies. I have argued that the key factors here are parsimony, invariance and a rejection of the supernatural.⁵⁰ With myths generally – creation myths in particular – I see no recognition of or commitment to the principle of parsimony. Indeed, for some myths, it may be preferable to be ontologically profligate in order to better fulfil their function. Hesiod, while he may attempt a systematisation of theogony, is not parsimonious in his theogony. Arguably, Thales is the first to give us a parsimonious philosophical cosmogony. Anaximander, with the *cosmos* generated out of a basic substance, certainly does.

It has been argued that an important factor in the move from mythology to philosophy was a de-personification of the factors controlling the universe, a move from 'thou to it' to impersonal forces.⁵¹ The issue is one of invariance rather than personification. That is, do the factors controlling the behaviour of the universe act in a regular and predictable manner? One might have a de-personified force which is not invariant. One might have a God which sees to it that the universe behaves in a perfectly regular manner. The *apeiron* for Anaximander may be divine, but it steers in an invariant manner.

The third aspect here of the move from creation tales to cosmogony is the rejection of the supernatural. That can be thought about in two ways, either from the modern perspective of a distinction between what we consider to be natural and supernatural or from an ancient perspective of what the Presocratics considered to be natural and non-natural. Myths are happy to employ supernatural entities. Anaximander employs only natural explanation as we saw in the chapter on meteorology.

Hesiod is often taken as a bridge between creation tales and philosophical cosmogony.⁵² There is no debate that, prior to Hesiod, there are creation tales rather than philosophical cosmogony. Ought we to consider Hesiod to give a philosophical cosmogony as well? There are two central considerations here.

First, is the result of the creation process for Hesiod a *cosmos*? If we mean by *cosmos* a world order that is parsimonious, invariant, consistent and natural, then the answer is no. The main consideration here would be the arbitrary or capricious interference of gods in the world. Second, are the processes of creation for Hesiod philosophical cosmogony? If by that we mean that these processes are parsimonious, invariant, consistent and natural, again the answer is no. The main issue will be arbitrary actions of the gods.

Aristotle puts Hesiod in a different tradition to the philosophical thought of the Milesians, and here I would agree.⁵³ The opening passage of Hesiod's *Theogony* is:

First a chasm was generated,⁵⁴ then broad-breasted Gaia (earth), a safe seat for all forever,⁵⁵ and misty Tartarus in a recess of the broad earth, and Eros, most beautiful of the immortal gods, relaxer of limbs, who subdues in their breasts the sense and intelligent counsel of all gods and all men. From the chasm, Erebus and black night were generated. From night, aether and day were generated, who she bore after sex with Erebus. Earth first generated something equal to herself, starry Ouranos, in order that she should be entirely covered, to be a safe seat for the blessed gods forever. Then she generated large mountains, happy haunts of the divine Nymphs who live in the wooded mountains. She also bore the unharvested sea, with its rolling swell, Pontos, but not in union of love. Then having had sex with Ouranos she bore deep-eddy Okeanos.⁵⁶

Can we consider the world of Hesiod to be a *cosmos*? The gods still interfere with processes on earth. The gods have sex with mortals not only to start the race of heroes, but also to keep them going. In *Works and Days* it is clear that Zeus will punish behaviour of which he disapproves.⁵⁷ As a more general point, we might compare justice as the whim and subsequent interference of Zeus against justice occurring of necessity in Anaximander's account of the opposites.⁵⁸

Hesiod gives us the tale of Prometheus, where deceit and jealousy among the gods lead to their interfering with the world by bringing mankind the gift of fire.⁵⁹ Hesiod also gives us the tale of Pandora's Box, a gift from the gods containing countless troubles for men.⁶⁰ I do not see how we can call this a *cosmos* in the same way that we call the worlds of the Presocratic philosophers *cosmoi*. I do not see a recognition of the importance of parsimony in the account of the world, there certainly is not invariance, and the natural world is suffused with supernatural happenings.

Second, can we consider the processes which bring about Hesiod's world to be philosophical cosmogony? If we take Hesiod in a suitable manner, we can see the *Theogony* generating earth, sky and sea. If Hesiod stopped there, we could

perhaps see some parsimony, in that he invokes only enough gods to match the essential parts of the world.⁶¹ However, this is very far from the case; there is a huge overuse of gods, titans, heroes, monsters, etc. who have no aetiological function in cosmogony at all. One might argue that Hesiod's work is multi-functional, giving a philosophical cosmogony and some myths within the one tale. Even then, though, we have many gods reproducing in many ways, and there is no real sense of any parsimony here. The theogonical process is dependent on the whims of the gods. Not content with sexual reproduction, there is also both male and female parthenogenesis without there being any cosmogonical reason for three processes.⁶² There is no sense of a distinction between or a separation of the natural and the supernatural, especially given the gods' habit of having sex with mortals. I do not see that we can call Hesiod's cosmogony a philosophical cosmogony in the same sense that we call the work of the Presocratics philosophical cosmogony. Again, I see no recognition of the importance of parsimony, the processes are not invariant and there is not a satisfactory distinction or separation of natural and supernatural processes. It remains to be seen whether the origins of philosophical cosmogony are with Thales and the other Milesians, but they are certainly not with Hesiod.

Uniformitarianism

An important theme for this book is that Anaximander was a uniformitarian in zoogony and cosmogony. His theories invoke the same sort of underlying processes we can still find going on in the world today rather than unique processes. Such an approach seems common to the Milesians. In Anaximander, the elements continue to separate out of the *apeiron* as some are dissolved back into it. There are no 'once and for all' actions on the part of the gods. Mansfeld has commented that:

There is also another problem with this equilibrium. Anaximander's cosmogony (like Hesiod's theogony) is a quite violent affair. What is more, it is reported that at some time in the future the sea will completely dry up. This information is incompatible with the idea of a cosmic equilibrium.⁶³

I do believe there is a cosmic equilibrium in Anaximander and we will look at the drying up issue in more detail in the next chapter. On the comparison with Hesiod, I disagree. As above, I see many fundamental differences between Hesiod and Anaximander here and I do not find Anaximander's cosmogony violent as

in Hesiod or indeed violent at all. One important issue here is how we take any similarities between cosmogony and zoogony for Anaximander. If we take the KRS view, we should interpret the zoogony in terms of the physical and mechanical processes of the cosmogony.⁶⁴ So there is an explosion for the earth and for the early creatures shedding their coverings. If we reverse this though, with the biological ideas prevalent, then the earth sheds its covering in a natural and gentle manner as part of its development in the same manner as the early animals. So cosmogony is not a violent affair for Anaximander on this view. I would also make a much less sharp distinction between cosmogony and the current state of affairs than does Mansfeld. If Anaximander was a uniformitarian, we still see the underlying processes continuing, giving much less of a contrast between a violent past and a gentle present.

Conclusion

It is a great pity that we do not have rather more evidence on Anaximander's cosmogony. The outline of the processes are reasonably clear, with the separation of opposites from the *apeiron* and their organisation into the *cosmos*, but the principles behind these processes are less clear and more contested. This chapter has argued for the importance of the *apeiron* being able to steer in Anaximander's cosmogony. Apart from the evidence of Aristotle, there is a reasonable amount of evidence on other Presocratics employing steering. The evidence from Plato is that there was a tradition of explanation which employed steering. The possibilities for that steering though are still quite broad. It could be that the *apeiron* is intelligent. Alternatively, it could be that Anaximander has some biological metaphor in mind and the steering is rather more like that of seed determining the growth and nature of a plant. It is important to recognise that there is steering for Anaximander though, as this is often underplayed in accounts of his cosmogony. This has consequences for the debate on whether Anaximander believed in a single, unique *cosmos*, successive *cosmoi* or multiple co-existent *cosmoi*. There are no vortices in Anaximander. The passage in Aristotle which is supposed to attribute them to Anaximander in fact does no such thing. Anaximander has no need of vortices or of a single vortex. While it is clear in post-Parmenidean thinkers such as the early atomists Empedocles and Anaxagoras, which entities would be involved in a vortex, it is by no means clear in Anaximander. Anaximander has no like-for-like principle for sorting anything in a vortex. This has implications for any supposed 'eternal motion',

which can neither be random nor in the *apeiron*, only of the *apeiron* as a whole. This has important implications for the mechanical/biological debate in Anaximander and also implications for whether there could be infinite co-existent *cosmoi*. I have argued here that Anaximander had a radically different view on cosmogony to that of Hesiod. Certainly there are influences from Hesiod and other pre-Anaximander cosmogonies, but I have argued that these are at a relatively superficial level. On the fundamental issues of how one puts a cosmogony together, and indeed what sort of world one is attempting to explain the genesis of, however, there are radical differences between Hesiod and Anaximander.

Anaximander: One *Cosmos* or Many?

There has been considerable debate on whether Anaximander believed there to be one *cosmos* or many. There are three positions here: that he believed in infinite co-existent *cosmoi*; in infinite successive *cosmoi*; or in a unique *cosmos*.¹ Back in the nineteenth century, Zeller argued for successive *cosmoi*;² at the beginning of the twentieth century, Burnet argued for co-existent *cosmoi*.³ Cornford demolished Burnet's version of co-existent *cosmoi*, arguing for successive *cosmoi*.⁴ Kirk and Kahn have argued for a single *cosmos*.⁵ More recently, West, Conche and McKirahan have argued for co-existent *cosmoi*,⁶ while Finkelberg has argued for successive *cosmoi*.⁷

In what follows, I argue for a single *cosmos* for Anaximander. I begin by discussing considerations relating to symmetry, general patterns and unlimited generation, which, I argue, favours a single *cosmos*. I then consider the stability of Anaximander's earth in a broader context, arguing that the equilibrium argument cannot work in a universe where other *cosmoi* are coming into and going out of existence. In relation to successive *cosmoi*, I argue that the evidence that Anaximander believed the earth to be drying out is minimal and suspect. I conclude the first part of this chapter by discussing whether Anaximander had the requisite beliefs to support multiple *cosmoi*. I ask what would motivate him towards multiple *cosmoi* and what they might explain for him, especially if Anaximander had a role for steering in cosmogony. It is noticeable that authors in favour of multiple *cosmoi* barely, if at all, mention steering.⁸

In the second part of this chapter I turn to the doxographic evidence. The evidence for multiple *cosmoi* in Anaximander stems initially from Aristotle saying that the unlimited 'surrounds all of the heavens'. I argue there is an innocent explanation for the plural here, whether it originates with Anaximander or with Aristotle. More radically, I argue there are other passages in Aristotle, not considered before in this debate, which indicate he did not attribute multiple *cosmoi* to Anaximander. Theophrastus is reckoned to have said 'all the heavens and the *cosmoi* within them' in relation to Anaximander. Again, I argue there is

an innocent explanation for the plurals here whether they originate with Anaximander or with Theophrastus. I then look at how the later doxographers, working from Aristotle and Theophrastus, might have been misled into believing that Anaximander favoured multiple *cosmoi*.

Co-existent *cosmoi*

McKirahan has made the best case for multiple co-existent *cosmoi* in Anaximander.⁹ In what follows I disagree with McKirahan on several points, but I believe he raises many important points and crucially addresses the issue of whether multiple co-existent *cosmoi* was a conceptual possibility for Anaximander. First, I agree with McKirahan that Anaximander was a bold and original thinker and we cannot reject the notion of multiple co-existent *cosmoi* for him out of hand.¹⁰ Kirk says that:

The idea of different worlds in time would be, surely, an absolutely extraordinary one for an early Ionian thinker.¹¹

There are at least two senses in which an idea may be extraordinary though. If what is meant is that this idea is strange, revolutionary or brilliant, then the simple reply is that Anaximander had several strange, revolutionary or brilliant ideas so we can hardly bar multiple *cosmoi* on these grounds. If what is meant is that this idea does not fit with Anaximander's pattern of thinking or his other beliefs as far as we can establish them, then there is a good deal to be done to show that that is the case. I am not convinced that Kirk achieved that. To some extent I agree with McKirahan's comment that:

Several prominent features of Anaximander's system could not have been based on empirical evidence.¹²

There are philosophical principles (sufficient reason being one) that are not based on empirical evidence, though I would argue that Anaximander does have empirical evidence for his accounts of cosmogony and zoogony. McKirahan's target, though, is the Cornford/Kirk view. Cornford argues that "There is nothing in nature to suggest innumerable worlds"¹³ and Kirk, following on from Cornford, argues that there is: "Nothing whatever in "the appearance of nature" to suggest *successive* worlds."¹⁴ However, that is going to be true for Leucippus and Democritus, and for Empedocles as well; they certainly believed in innumerable co-existent worlds and single successive worlds respectively. In any case, multiple

cosmoi was not an empirical thesis, on the evidence we have, but rather a supposition aimed at explaining why our *cosmos* has the order it has.

Does Anaximander have a conception of the *apeiron* which would support the idea of multiple co-existent *cosmoi*? The issue here is that Leucippus and Democritus do have a conception of infinite space which supports multiple co-existent *cosmoi*. McKirahan comments on Anaximander's *apeiron* that:

It is widely agreed that it is 'indefinitely huge in [its] extent'.¹⁵

It is true that this is widely agreed. I disagree. I would say, for Anaximander, that the *apeiron* is spatially unlimited, but finite. I think it is improper, both philosophically and on the evidence we have about Anaximander to use an adjective like 'huge' in this context. An unlimited but finite *cosmos* may be of any size.¹⁶ Do we have evidence that for Anaximander the *cosmos* is 'indefinitely huge in [its] extent'? We do not. It may be that Anaximander (quite properly in my view) simply held the *apeiron* to be spatially unlimited and did not qualify that in any way, the internal boundaries being a more important topic for him than the external. One concern over 'indefinitely huge in [its] extent' is that, while not collapsing Anaximander's view into that of Leucippus and Democritus, it cedes too much to an infinite space view and so assimilates Anaximander too closely to Leucippus and Democritus.

Symmetry considerations

I agree with McKirahan that Anaximander's system 'has strong tendencies towards symmetry' and that includes not only the structure of the *cosmos* but the processes Anaximander employs in cosmogony as well.¹⁷ It is then possible to argue that the *cosmos* should have a death as well as a birth as part of that symmetry.¹⁸ There are, though, other ancient thinkers with a strong tendency towards symmetry who believed that the *cosmos* began but that it will not end. Plato is perhaps the key figure here as his craftsman god, the *demiourgos*, brings the *cosmos* into being out of chaos.¹⁹ There are considerable tendencies towards symmetry in that cosmology at all levels. The account of the elements (both the simple plane triangles and the three-dimensional elements they generate) makes use of symmetry, as do the accounts of the generation of human beings and the *cosmos* on a large scale. The generation of the *cosmos* for Plato is, of course, good. In the *Timaeus* he says that:

God desired that all things should be good, and nothing paltry as far as was possible, he took over all that was visible, which was not at rest but in discordant and disorderly motion, and led it into order out of disorder, judging the former to be entirely better than the latter.²⁰

The *Timaeus* is entirely clear that the *cosmos* will be everlasting. The demiurge says that:

I am the craftsman and father of these works, and they are indissoluble except by my will. Although all that is bound can be dissolved, to will to dissolve that which has been beautifully and well constructed would be bad.²¹

The key asymmetry for Plato is that order is seen as something good. No intelligent, conscious agent is going to will that something bad, such as the dissolution of the *cosmos*, will happen. That Anaximander envisaged something with good order is beyond doubt, if we consider the centrality and stability of the earth, its suitability for life and the precise arrangement of the heavenly bodies. What the symmetry consideration masks is that there is no reason, either ethical or physical, for Anaximander's *cosmos* to go into decline. That is especially so if the *apeiron* is steering, and continues to steer, the *cosmos* into being. There is no indication that the *apeiron* ceases in this activity once the *cosmos* is formed.

We might, of course, ask just how conscious and ethical Anaximander's divine, steering *apeiron* was. Ultimately we do not have an answer for that. It would be as inappropriate to impose Plato's ideas on Anaximander as it would be to impose those of the atomists, though conscious, intelligent steering is certainly one possibility. We do not need anything quite as strong as this though. Anaximander does not need a full understanding of Plato's teleology or his conception of a craftsman god who only has the good in mind. All that is needed is that the *cosmos* is seen as something good and that, once in place, the steering *apeiron* has no reason to dissolve the *cosmos*, but has reason to maintain it by further steering, even if this is more akin to the growth of a plant from a seed and the subsequent nutrition of the plant.

General patterns

McKirahan argues that:

Anaximander's tendency to see events as instances of general patterns that occur in other places and at other times and in different contexts might well have led

him to hold that the process that generated our world is not unique and in consequence unintelligible.²²

I agree with McKirahan that Anaximander (and indeed Thales and Anaximenes) tend to see events as instances of general patterns, and this, as part of a break from mythology, is much to their credit.²³ I would put the consequences in a slightly different way though. The Milesians see cosmogony as a process by which the *cosmos* is formed over time, rather than an instantaneous (or short-lived) event. The processes by which the *cosmos* are formed are ongoing and are a permanent part of nature. They see no need to invoke anything other than the processes they see in action around them in order to explain the origins of the *cosmos*. Again, against a background of mythology and theogony, this is greatly to the Milesians credit. Is the cosmogony of a unique *cosmos* unintelligible for them? Not at all. As cosmogony is now a natural occurrence and, in a sense, an ongoing process, it can be explained as part of the general pattern of the action of current physical processes. If Thales and Anaximenes also see events as instances of general patterns, McKirahan's argument would generate multiple co-existent *cosmoi* for them as well.

The Milesians appear to appreciate the value of philosophical parsimony. They make a small number of principles work hard to cover all of the phenomena and they do not invoke further principles. What, then, would they gain through invoking multiple *cosmoi*? This is not an empirical thesis as no one can (or even claims to be able to) observe further *cosmoi*, nor can they experience previous or future versions of successive *cosmoi*. What might the supposition of multiple *cosmoi* explain? In other hands, it is used to explain how a beneficial *cosmos* came about by chance or is used as a reply to Eleatic concerns.²⁴ None of this worries Anaximander and this is one reason why it is important to recognise him as a pre-Parmenidean thinker. His unique *cosmos* comes together guided by the steering principle, he has a centre to his universe where the *cosmos* can exist and the puzzles of Parmenides are in the future. Multiple co-existent *cosmoi* are simply otiose for Anaximander.

A further general pattern consideration is that of Anaximander's zoogony. What sort of explanation of the origins of animals and humans do we get? Even those who argue that there is some form of proto-Darwinism in Anaximander will admit that one thing missing from his account is any sense of chance or a multiplicity of accidents leading to the generation of new species. This is important, as the early Greek thinkers did co-ordinate their views on cosmogony and zoogony in line with their explanatory principles. Empedocles notoriously

gives us his nightmare scenario of multiple accidents leading to zoogony and anthropogony, with various parts of the body roaming the earth until they fortuitously join up to form viable species which are able to reproduce. In terms of cosmogony, Empedocles again has a large role for chance and has successive *cosmoi* which are significantly different from each other.²⁵ Plato, on the other hand, is a good example of design. There is one *cosmos*, designed by the *demiourgos*. There are distinct species, again designed by the *demiourgos*. Plato even goes as far as to say that there are two mathematically well-designed basic particles. These make up the small number of mathematically well-designed geometrical solids that are his elements of earth, water, fire and air.²⁶ It seems to me to be a very harsh judgement on Anaximander to suggest that he had multiple co-existent or successive *cosmoi* but did not employ the explanatory principles behind those views to his zoogony, or vice versa.

Unlimited generation?

McKirahan argues that:

If the apeiron original substance generated a world in one place, it would generate worlds elsewhere too – without limit.²⁷

One might quote Metrodorus of Chios, a pupil of Democritus, in support, who says that:

It is strange for one ear of corn to be produced in a great plain, and for one world in the boundless.²⁸

There are several replies to this line of argument. The first would be deflationary, that Anaximander is a pre-Parmenidean and that these sorts of considerations only come to the forefront of Greek thought with the early atomists. That does not rule out the possibility that they might still exist prior to the early atomists.

More significant is the reply that if *cosmoi* might form elsewhere, why not everywhere else? If a *cosmos* forms at one point, why not all points, assuming that all points are equal? Literally everywhere else would be absurd (i.e. at every point in space), but why would we get an appropriate spacing of multiple *cosmoi*? I have argued elsewhere that critical to the early atomist account of the generation of *cosmoi* is their deployment of the *ou mallon* principle.²⁹ Translated literally, it means ‘not rather’ as in a sentence such as ‘not x rather than y’. This does not

mean a preference for y ; rather it asserts an indifference, or lack of preference between x and y .³⁰ So for Leucippus and Democritus on the sizes and shapes of atoms, Simplicius tells us that:

Leucippus supposed there to be an infinite number of atoms that are always in motion and have an infinite number of shapes on the grounds that nothing is such rather than such (*dia to mêden mallon toiouton ê toiouton einai*).³¹

Simplicius' wording here suggests that *ou mallon* is a general principle for what is rather than something which applies only to the shapes and sizes of atoms.³² Indeed, Leucippus and Democritus use this principle in a wide variety of situations. For the early atomists, there are no preferred points in either space or time. So why is there *cosmos* formation at specific points and times? For Leucippus and Democritus, *cosmos* formation is *ou mallon* with respect to space and to time.³³ One might argue that *ou mallon* is implicit in Anaximander's equilibrium account of the earth's stability, the earth having no preferred direction to move in, but there is no evidence that Anaximander used *ou mallon* in relation to space, time and *cosmos* formation.

If Anaximander accounts for the stability of the earth by placing it in the middle, 'established in the centre and having equal relations to the extremes', as Aristotle puts it, then all places are not equal. One issue here is whether we treat the generation of *cosmoi* in Anaximander on a par with the generation of *cosmoi* in Leucippus and Democritus. In the early atomists, the generation of *cosmoi* is purposeless, unguided and, in one sense, mechanical.³⁴ We then have *cosmoi* being generated at random points throughout infinite space. If we recognise a role for the steering principle on cosmogony for Anaximander though, his account then looks quite different. Steering can generate a single well-ordered *cosmos* without any need for that to be replicated in other parts of the *apeiron*.

The stability of the earth

Anaximander's account of the stability of the earth, effectively that the earth is symmetrical and at the centre of something homogenous can only work if the surrounding heavens are indeed uniform.³⁵ For a single *cosmos* in Anaximander, that can work as long as the rings around the earth are uniform and there is only the *apeiron* outside them. However, one will not get this uniformity on the early atomists' account. Indeed, if *cosmos* formation is *ou*

mallon with respect to time and place, one would not expect it. We also have the evidence of Hippolytus, who says:

The spaces between *cosmoi* are not equal, in places there are more and in others less.³⁶

These concerns would explain Stobaeus' comment that:

Of those who claimed the *cosmoi* to be unlimited, Anaximander held that they were equally far away from each another.³⁷

However, there are questions of reliability and plausibility here. We only find this in Stobaeus and not any earlier source. Given that Stobaeus did not have access to Anaximander's writings himself, where does this come from? Stobaeus' comment looks like a rather desperate attempt to save a multiple co-existent *cosmoi* view of Anaximander in conjunction with his account of the stability of the earth. One can possibly imagine this as a static conception of the universe if *cosmoi* have no motion in relation to one another and they are permanent features of the universe. Prominent cosmologists have explored such views throughout history (Newton and Einstein among them) where the universe is said to have 'knife edge' stability.³⁸ However, this is not the atomist view. There is a permanent flux of *cosmoi* coming into and passing out of existence. Hippolytus Eusebius, P.E. XIV, 22, 3 also tells us that:

Some are growing, some are in their prime, some declining, some are coming to be and others failing. They are destroyed by collision with one another.

So there must be relative motion between the *cosmoi* as well. Could knife-edge stability be Anaximander's view? This approach is implausible because if these other *cosmoi* are coming into and out of existence, unless pairs of them do this in a synchronised manner the balance for the earth will be upset and that looks most unlikely.³⁹ One might argue that steering does the trick here, ensuring that the *cosmoi* are equally spaced and that their deaths are co-ordinated, as this is utterly implausible on any chance or *ou mallon* account of co-existent *cosmoi*. That, too, looks implausible, as it is unclear what all these equally spaced and temporally co-ordinated *cosmoi* are there to explain. There is also a more universal issue here. If there are co-existent *cosmoi*, each will have an earth and that earth will be stable. That is not a problem for the early atomists, as each *cosmos* has a vortex. It is a problem for Anaximander, as any change in the whole (a *cosmos* in motion, a *cosmos* coming into or out of existence) will affect the equilibrium of all other earths and *cosmoi*. Trying to balance this with

synchronised change is not, then, just a matter of doing so for our earth/*cosmos*, but for all the earths/*cosmoi*, taking earth to be the central body of a *cosmos*. The simplest solution here by far is that Anaximander believed in one *cosmos* in the middle of the homogenous *apeiron*.

Successive *cosmoi*

There is also the view that Anaximander believed in single, successive *cosmoi*, the next one not coming into existence until the present one has perished. Kirk's argument that the material of the world is divine is well answered by Finkelberg, who points out that no one disputes that the divine material is eternal; the question is whether the *cosmos*, which is generated from the divine and eternal *apeiron*, could be dissolved back into the *apeiron*, the *cosmos* being a temporary arrangement.⁴⁰

Anaximander's conception of space is not so critical for the successive *cosmoi* view. The single *cosmos* can occur again and again at the centre of an unlimited but finite space. It can be claimed that the regularity of nature and the cyclical nature of change in Anaximander supports the idea of successive *cosmoi* following each other at regular intervals, rather than the irregularity of the co-existent *cosmoi* or the irregularity of the succession of *cosmoi* of the early atomists. However, Anaximander's conception of time is critical to this view. If time surrounds the *cosmos*, or the *cosmoi*, there is time before the first *cosmos* and, at least potentially, time after the last. In an infinite successive world view, there should not be time before or after *cosmoi*, and no first or last.

How well does the idea of successive *cosmoi* fit with the rest of Anaximander's thinking? Where we find clear-cut cases of successive *cosmoi*, as with Empedocles and the Stoics, we also find strong criteria for differentiating between successive cycles. In Empedocles there are the states of total association and total dissociation of the elements. In the Stoics there is the process of *ekpurōsis*. We find nothing of this sort in Anaximander.

To establish the successive *cosmoi* view, it is not sufficient simply to argue that Anaximander is committed to 'everything is generated out of x and will be destroyed into x'. There are two reasons for this. First, Thales is committed to an 'out of x . . . into x' formulation, but there is no suggestion that he is committed to successive *cosmoi*. Second, once the opposites have been generated, it is quite possible that some are destroyed without, at any stage, all of those instances being destroyed. This would allow the *cosmos* to continue to exist even if every

instance of the opposites which constitute it at this moment will ultimately be destroyed. This I take to be the point of Diogenes Laertius' comment that the parts change but the whole does not. It is important to recognise here that at no point does Anaximander say that the *cosmos* is destroyed back into the unlimited.

The earth drying out?

One possible motivation for successive *cosmoi* in Anaximander is that he is supposed by some to believe that the earth is gradually drying up. The evidence for this view originates from a passage in Aristotle's *Meteorology*, II/1, 353b6 ff., where he says that:

At first the whole area surrounding the earth is moist, but due to the drying of the sun, that which is evaporated makes winds and the turnings of the sun and moon, they say, while that which remains is the sea. Thus they think it is becoming less through being dried up, and will at some point end up being entirely dry.

Aristotle does not refer to Anaximander here, nor does he suggest anywhere else that Anaximander held the drying up theory. He does discuss the theory that the sea is terminally drying up (*Meteorology*, 357a) but he attributes this to Democritus. There is nothing in Anaximander to support such an attribution. It has been suggested that he may have witnessed the silting up of rivers or harbours or possibly the recession of the sea along parts of the coastline. That establishes very little though, as Aristotle's view was that any recession of the sea was only local, and was compensated for by an advance of the sea in other places.⁴¹ There is no reason to suppose that Anaximander believed in a terminal drying up of the earth on such evidence. However, in his commentary on this Aristotle *Meteorology* passage, Alexander, *Meteorology*, 67, 11 tells us that:

Of this view were Anaximander and Diogenes, according to the history of Theophrastus.

We do not know what Theophrastus may have based this assertion on. It may have been some knowledge of Anaximander that is now lost, though one would have to question why that information was available to Theophrastus but not to Aristotle.

It has been suggested that the drying up of the earth is part of a cycle, perhaps part of a great summer to be followed by a great winter.⁴² I do not think that will quite do, as it would seem unlikely that the earth would revert to being surrounded entirely by moisture. I disagree with Mansfeld's comment though, that:

The best one can do is to argue (like Schleiermacher a long time ago) in favour of the complementary natural catastrophes of flood and conflagration in a so-called great year.⁴³

The drying out of the earth need not be a completely reversible process. The first part of this may be cosmogonic, in forming the fully fledged earth and its systems. Some water may evaporate to 'prime' the weather system, but when more water evaporates it will condense, fall as rain and replenish the sea. Hippolytus, *Refutation of All Heresies*, I, 6, 7 tells us that for Anaximander:

Rain comes from the vapours which are raised from things below the sun.⁴⁴

The idea that there was a weather cycle and that clouds and rain came from evaporation of sea water and fresh water was common in antiquity and can be traced back to Xenophanes.⁴⁵

Anaximander may not have made any clear statement about the future of the *cosmos*, simply because the total drying up of the earth and its implications for successive *cosmoi* may not have been an issue for him, if the cosmogonic drying out was supposed to result in an equilibrium of evaporation and rainfall. Theophrastus may have interpreted the cosmogonic drying out as a terminal process when no such process was intended. Here the uniformitarian point about Anaximander is important. We should not make a radical separation of the processes of cosmogony and what we see going on today.

There is an assortment of puzzles if we take it that the earth is in the process of terminal drying out for Anaximander. First, where does the moisture go if the earth is getting drier. We need to see this in a broader context. It is important to note here that the *cosmos* is not getting drier, just the earth, as dry and wet are redistributed within it. As I argued earlier, the *cosmos* cannot be getting drier if there is equitable generation and destruction of pairs of contraries. Why should that redistribution result in the end of the *cosmos*? There is nothing here about re-absorption back into the *apeiron* or the dissolution of the *cosmos*. Or is Anaximander's *cosmos* like Heraclitus' *kukeon*? Heraclitus says that:

Even the *kukeon* separates unless it is stirred.⁴⁶

The *kukeon* was a drink made of barley meal, grated cheese and wine,⁴⁷ which would separate out very quickly unless it was stirred. So perhaps Anaximander's *cosmos* gradually falls apart? If that is so, why do we not get the redistribution of other pairs of qualities like hot and cold?

If the earth is getting dryer, why is this happening? This is a different question to those of physical processes, as I would like to know why the earth is in a

process of terminal drying out if the *apeiron* steers. I see no evidence that the *apeiron* ceases to steer at any point. If it has brought the *cosmos* into good order, why does it let it deteriorate?

I also disagree with Theophrastus/Alexander on Diogenes. I see no evidence that Diogenes was committed to any sort of drying out, let alone a terminal one. There is an interesting parallel between Diogenes and Anaximander, though, as both explain rain in terms of the sun and subsequent rainfall. So:

Diogenes of Apollonia says that the water of the sea is drawn up by the sun, and then falls in the Nile. He believes that the Nile floods in the summer on account of the sun turning it into moist secretions from the earth.⁴⁸

So on the basis that Anaximander and Diogenes believe that rain is generated by the action of the sun, does Theophrastus incorrectly attribute to them the full view that the earth is terminally drying out? Finkelberg has argued that:

One can claim that Aristotle was also mistaken in reporting the Anaximandrian doctrine of the progressive drying up of the moisture in a way that suggests its irreversible character; this is possible, just as it is possible that he was mistaken about Thales' principle or about Anaximenes' account of earthquakes.⁴⁹

I do not see that these are parallel cases though. We have a direct, named attribution in Aristotle for the cases of Thales' principle and Anaximenes' account of earthquakes. We do not have this for Anaximander and drying out. We only have Alexander's report of Theophrastus' association of Anaximander and Diogenes with this view and the association with Diogenes seems incorrect.⁵⁰

Many commentators are puzzled by the apparent discord between the extant fragment and the supposition that the *cosmos* will dry up and be reabsorbed by the *apeiron*.⁵¹ There is no need. Anaximander simply did not believe that the earth was terminally drying out, let alone that the *cosmos* was terminally drying out.⁵²

Explanation and multiple *cosmoi*

I want to look now at what multiple *cosmoi* (whether co-existent or successive) are supposed to explain and how they are supposed to be explanatory. Let me begin by returning to a comment by Kirk and putting that into a slightly fuller context. Kirk says that:

The idea of different worlds in time would be, surely, an absolutely extraordinary one for an early Ionian thinker, whose object, judging from the other evidence, was to explain *our* world and account for its coherence.⁵³

I disagree with Kirk here, as I take both the successive *cosmoi* theory and the co-existent *cosmoi* theory to be attempts to explain our world and its coherence. The point is one of explanatory principle. One way of attempting to explain the order of our own world is to say that it is the product of some form of design. Another is to eschew all design principles and to have a multiplicity of accidents and a multiplicity of worlds. The order of our world is then accidental and we explain the nature of our world as one of an infinite array of different, accidental worlds. The classic statement of this in the ancient world is that of Lucretius:

So many primordial particles, in a multitude of ways have been propelled by their own weight and impacts for an infinite amount of time, and have made trial of all things their union could produce, it is hardly surprising if they have come into arrangements and patterns of motion like those repeated by this world.⁵⁴

Lucretius held co-existent *cosmoi*, but one can also do the same thing with successive *cosmoi*, if they are different from one another and there is some accidental factor in their generation. So I do not think we can dismiss successive or co-existent *cosmoi* for Anaximander on the grounds that he was trying 'to explain *our* world and account for its coherence'.⁵⁵ I argued in my *Ancient Greek Cosmogony* that there is a sharp divide in the ancient world between those who explain the order of our *cosmos* as a single *cosmos* with some form of design factor and those who believe in multiple *cosmoi* with a multiplicity of accidents.⁵⁶ I find it a significant fact about the ancients that no one believed there to be a single *cosmos* which came about by chance. A single *cosmos* was always ordered in some way, though there were many ideas on how this ordering might come about. We might now ask, which side of this divide was Anaximander on? A crucial consideration here has to be that the *apeiron* steers. If the *apeiron* steers the *cosmos* into being, and in so doing generates all the order in the *cosmos*, then Anaximander has no need of multiple *cosmoi*, either co-existent or successive. At no point in any of the evidence does Anaximander talk of accidents or a multiplicity of accidents. There is no language of chance or even any hint of it. Nor is there any trace of an *ou mallon* argument in relation to space and time.

Where we find a clear belief in multiple co-existent *cosmoi* in antiquity, unsurprisingly we find clear boundary conditions and individuation criteria for

those *cosmoi*.⁵⁷ So with Leucippus and Democritus, and with Epicurus and Lucretius we find that there is a physical boundary for each *cosmos*. They are keen to assert what makes a *cosmos* one *cosmos* and differentiates it from the rest of the universe. Such criteria allow us to count one *cosmos*, two *cosmoi* . . . many *cosmoi*. This is absolutely fundamental to a co-existent *cosmoi* view, but we find nothing of this sort in Anaximander. One might argue that as Anaximander precedes Leucippus and Democritus, he may have been less clear about or not dealt with these issues, but some form of boundary and individuation criteria seem essential if one is going to argue for multiple *cosmoi*. It is significant that everyone who did argue for co-existent and even successive *cosmoi* gave boundary and individuation criteria.⁵⁸

There are many other conceptual issues which would indicate that Anaximander did not believe in multiple *cosmoi*. There is no reason to suppose random eternal motion, vortices or a like-for-like principle in Anaximander. I have argued that his *apeiron* is best considered as finite but unlimited; this would rule out infinite co-existent *cosmoi*. If the *apeiron* is thought to surround the cosmos temporally as well as spatially, that would also rule out infinite successive *cosmoi*. There is also Kahn's point that Anaximander refers to the *apeiron* as the divine, which he would hardly do if it were the 'formless nightmare' appropriate to generating and surrounding infinite *cosmoi*.⁵⁹ One might also contrast the regularity of change in the extant fragment against the irregularity of *cosmos* generation in the early atomists.⁶⁰ In Anaximander the earth is stable due to equilibrium considerations. We do not find this view in any multiple co-existent *cosmoi* theorist. This is no surprise, as the equilibrium theory is incompatible with a random distribution of *cosmoi* and a changing distribution of *cosmoi* where *cosmoi* are being generated and destroyed. Finally, we might think about the issue of cosmic justice. If Anaximander did think that it was just or proper that there is a balanced interchange of powers or even that a well-organised *cosmos* came into being that, too, differentiates him very sharply from the atomists. There is no motivation for multiple *cosmoi* in Anaximander; they would have no explanatory role and they are conceptually inappropriate for him.

The doxography

Let us now look at the doxographic evidence on multiple *cosmoi* for Anaximander. I would bring in one passage that is rarely commented on in this context, which is from Diogenes Laertius, *Lives of the Philosophers*, 2, 1–2:

καὶ τὰ μὲν μέρη μεταβάλλειν, τὸ δὲ πᾶν ἀμετάβλητον εἶναι.

The parts change, but the whole is changeless.

That, in my view, is correct for Anaximander.⁶¹ The constituents of the *cosmos* may change but the *cosmos* itself does not. The context here (the next lines describe earth, moon and sun) would indicate that the whole here is the *cosmos*. Now τὸ πᾶν here may possibly refer to everything for Anaximander, including the *apeiron* as well as the *cosmos*. If so, that matters little. If the *cosmos* were to go out of existence, to be succeeded by another, that would be a change in τὸ πᾶν as *cosmos* generation is not instantaneous. The sort of change that I suggest is appropriate here is that as pairs of contraries are dissolved back into the *apeiron*, equivalent amounts of those contraries are generated, perhaps under the guidance of steering. Thus, the parts would change but the whole would be constant.

Against this there is considerable doxographic testimony on multiple *cosmoi*. McKirahan comments that:

It does appear, though, that those who want to deny infinite worlds in Anaximander have a great deal of evidence to impugn.⁶²

In a sense that is true, but as the views of Stobaeus, Pseudo-Plutarch, Hippolytus and Simplicius all seem to be derived from Theophrastus, then the number and seeming unanimity of the testimony here is, in fact, rather less impressive. The real issue here is whether Aristotle and/or Theophrastus were in error or said things which misled the later doxographical tradition. As I have argued that for Anaximander there was only a single *cosmos*, why is the doxographical tradition in error? Let us first be clear that such a doxographical tradition can be wrong. The orthodox modern view of Heraclitus is that he supposed there to be one *cosmos* only, not successive *cosmoi*. However, Aristotle, Theophrastus and the following doxographical tradition all attribute successive *cosmoi*. In the later doxographers, Heraclitus is given the Stoic *ekpurôsis* theory.

I want to start a couple of points which are not often raised in discussions about the number of *cosmoi* for Anaximander, which is the number of *cosmoi* attributed to Thales. Stobaeus' list of those believing in a single *cosmos* is Thales, Pythagoras, Empedocles, Ekphantus, Parmenides, Melissus, Heraclitus, Anaxagoras, Plato, Aristotle and Zeno. Pseudo-Plutarch simply tells us that Thales believed in one *cosmos*. This supports a point I made earlier, that to establish the successive *cosmoi* view, it is not sufficient simply to argue that Anaximander is committed to 'everything is generated out of x and will be

destroyed into x'. Thales is committed to a similar formula but is not credited with multiple *cosmoi*. The second point is that these lists given by Stobaeus and by Pseudo-Plutarch do not inspire me with confidence. Whether or not Stobaeus elsewhere recognises that Empedocles has successive *cosmoi*, placing him in the same list as Plato and Aristotle who most definitely do not, without any explanation, is certainly not a sophisticated way of presenting the evidence.⁶³ Stobaeus' list of those believing in co-existent *cosmoi* is Anaximander, Anaximenes, Archelaus, Xenophanes, Diogenes, Leucippus, Democritus and Epicurus. Of those, I would dispute Anaximenes, Archelaus, Xenophanes and Diogenes.⁶⁴ I am also concerned about the phrase 'there are infinite worlds in the infinite', as that would at best gloss over the differences between Anaximander and the early atomists on space and looks like Stobaeus is treating Anaximander as if he has a similar conception of space to Leucippus and Democritus. It is not unknown for Stobaeus and Pseudo-Plutarch to take up different positions, so Pseudo-Plutarch tells us that:

Xenophanes, the *cosmos* is ungenerated, eternal and imperishable.⁶⁵

That seems flatly to contradict what Stobaeus has in his list for Xenophanes. The doxographical tradition then is, at least in part, confused and contradictory on issues of the number of *cosmoi*.

The doxography sequence

The passage in Aristotle which might be construed as attributing multiple *cosmoi* to Anaximander is *On the Heavens*, III/5, 303b10–13:

Some hypothesise one alone, water, air, fire or something rarer than water but denser than air, and this they say is unlimited and surrounds all of the heavens (πάντας τοὺς οὐρανοὺς).

The key point here is the plural 'all of the heavens' (πάντας τοὺς οὐρανοὺς), which has been taken to mean 'all of the worlds'. One can try to deny that Anaximander is meant here as Aristotle attributes an intermediate substance,⁶⁶ or say that we can hardly rely on the rest of this passage if Aristotle attributes an intermediate substance to Anaximander in the first part of it. Even if we do take this as referring to Anaximander, and properly ascribing *ouranoi* to him, there are several other possible readings here. Aristotle distinguishes three senses of *ouranos* (heaven) in *On the Heavens*, and it is possible here that he does not

intend to attribute multiple heavens, only multiple rings of stars, moon and sun.⁶⁷ It is also possible that Aristotle is quoting or paraphrasing Anaximander, who did refer to the heavens in the plural, but was referring to the rings of his own system rather than to multiple heavens.⁶⁸ One reason Anaximander might have done that is to distinguish his view of a *cosmos* with depth against the singular usages in Homer and Hesiod.⁶⁹ In my view his celestial wheels are complex, well-organised entities separate from each other, which might well lead either Anaximander or Aristotle to term them *ouranoi*.⁷⁰

I am suspicious of this passage being considered to attribute multiple *cosmoi* to Anaximander for several further reasons. First, this would be the only place that Aristotle attributes multiple *cosmoi* to Anaximander. Aristotle is very keen to attack this idea in other thinkers: he mentions their views in several contexts. Second, Aristotle is one of our sources for the equilibrium theory of the stability of the earth in Anaximander. He is, of course, critical of this theory, but not on the grounds that what surrounds the earth is not uniform (as one would expect with multiple co-existent *cosmoi*) or that something that is undergoing the later stages of terminal decay could hardly be expected to be stable on these grounds. Third, we need to consider this passage in relation to some others in Aristotle, such as *On the Heavens*, I/10, 279b13 ff.:

Everyone believes it to have been generated, but some believe it to be eternal once generated, others believe that it is destructible like any other formation in nature, while others believe that it alternates, at one time being as it now is, and at another time changing and going to ruin, such as Empedocles of Acragas and Heraclitus of Ephesus.⁷¹

Anaximander is here conspicuous by his absence. Aristotle recognises that there are those before him who believed that the *cosmos*, once generated, was eternal. Aristotle overestimates the number of successive *cosmoi* theorists here, but Anaximander still does not get a mention. Aristotle also says that:

They say that nothing is ungenerated, and that everything is generated. Once generated, some things remain deathless while others again perish. Hesiod and his followers take this position, as do the first of the natural philosophers.⁷²

This is very significant, as one must wonder who the 'first of the natural philosophers' might be. The most natural assumption would be the Milesians, especially as Aristotle uses a similar phrase at *Metaphysics*, I/3, 983b6 to refer to them. I doubt, then, that Aristotle attributed multiple *cosmoi* to Anaximander. That Hesiod believed the *cosmos* to have a beginning but to be eternal is

important in showing that this idea is quite possible just prior to the Milesians. One might also note that it is quite common around the time of Hesiod for the gods to be thought to have births but to be immortal. This provides a perfectly coherent alternative to the notion that the *cosmos* in the Milesians must die, having been born. As Kirk comments on this sort of objection:

As for the argument that what was born must die, one has only to think of the widely scattered myths of the birth of Zeus, for example, to dispose of that.⁷³

Mansfeld has commented that:

Anaximander's explanation of the generation of the world as a natural process comparable to the generation of, say, a tree, or a marine animal, unavoidably suggests that, just as such a tree or animal, the world too will at one time come to its end.⁷⁴

Here I disagree on two grounds. First, we only have to look to the living world soul of Plato's *Timaeus* to find a generated, organic living *cosmos* which will not decay or die. Second, as discussed in relation to politics and the extant fragment, Anaximander does not project actual political relations onto the *cosmos* but ideal ones. Here he may project an ideal, immortal life on the *cosmos* rather than an actual mortal one.

It is also interesting that we have no information whatever on whether successive *cosmoi* for the Milesians would be similar or different. This was a major debate in later antiquity after the Stoics formulated their theory that successive *cosmoi* would be identical, in contrast to the different *cosmoi* of either groups of atomists or Empedocles. Aristotle had already asked some of the key questions though, wondering if a god was in charge of cosmogony, why the succeeding *cosmos* would be better, worse or the same, and rejecting answers to all three possibilities and so the notion of successive *cosmoi* as well.⁷⁵

Theophrastus

Theophrastus, according to the standard reconstruction from the later doxography,⁷⁶ used the phrase 'all the heavens and the *cosmoi* within them' (ἅπαντας γίνεσθαι τοὺς οὐρανοὺς καὶ τοὺς ἐν αὐτοῖς κόσμους), from Simplicius, *Commentary on Aristotle's Physics*, 24, 13. Hippolytus, *Refutation of All Heresies*, I, 6, 1 has 'the heavens and the *cosmos* within them' (τοὺς οὐρανοὺς καὶ τὸν ἐν

αὐτοῖς κόσμον). While some scholars have sided with Simplicius here,⁷⁷ reckoning him to be the more reliable source, siding with Hippolytus gives a very simple and plausible reading, that there is a single *cosmos* within the *ouranoi*, understood as the wheels of the stars, moon and sun. Let us assume, though, that in the source for these passages, Theophrastus had *cosmos* in the plural. That may or may not have meant that he ascribed multiple worlds to Anaximander. A simple explanation would be that Anaximander believed in an antipodean culture on the other face of the earth separate from our own and so there were two political/social *cosmoi*, within the *ouranoi*, the celestial wheels. If Anaximander believed in a cycle of human civilisations he might refer to each civilisation as a *cosmos*, there being many civilisations over time, but no successive worlds.⁷⁸ Alternatively, Aristotle refers to different regions of the terrestrial realm as *cosmoi*. At *Meteorology*, 355a22–3 he talks of τῆς γῆς, καὶ τοῦ κόσμου τοῦ περὶ τὴν γῆν, ‘the earth and the *cosmos* around the earth’. One might then have several of these *cosmoi*, understood as organised parts, within a whole single *cosmos*. Again, it is important to recognise here that there are two sides to the earth for Anaximander [e.g. each may have a weather system associated with it (originating from water sitting in the curved face of the earth, organised and systematic enough to be termed a *cosmos*) where the edge of the earth does not, giving a border between the two systems]. There is also an interesting passage in the pseudo-Hippocratic *On Sevens*:

The *kosmoi* above the earth are equal in number and similar in form to those underneath the earth.⁷⁹

There are dating issues with *On Sevens*, but if this is early (c. C5 BCE), then we have an early use of *cosmoi* relating to organised areas. Anaximander may have used *cosmoi* similarly, while if it is later, then *cosmoi* in Theophrastus need not immediately be taken as infinite worlds.⁸⁰

If Theophrastus did attribute multiple *cosmoi* to Anaximander, that may be because he perceived that was the implication of some things that Aristotle said. He may have interpreted Aristotle’s remarks on the drying-up process as both applying to Anaximander and as attributing an ongoing, terminal process, leading to the end of the *cosmos*. It is significant that Theophrastus also gives Heraclitus a theory of successive *cosmoi*, in this case the *cosmos* becomes more fiery. The fact that Aristotle spoke of ‘all of the *ouranoi*’ and Theophrastus quite probably of ‘all the *ouranoi* and the *cosmoi* within them’ may have misled the doxographers, even if the initial use was innocent. The following passage in Aristotle may also be significant:

If what exists outside of the heaven is unlimited, then so it would seem is body, and so are *cosmoi*. For why here in the void rather than there? If matter is in one place, it will be in all. Similarly, if void and place are unlimited, then necessarily so is body.⁸¹

The critical passage here is 'If what exists outside of the heavens is unlimited, then so it would seem is body, as are *cosmoi*.'⁸² In my view, Aristotle only has the early atomists in mind here. Reading this though, one might then jump to the conclusion that anyone who posits an unlimited is then committed to an unlimited number of *cosmoi*. Whether or not this passage was significant for Theophrastus, it almost certainly was for the later doxographic tradition. In relation to the doxography on multiple worlds in Anaximander, I would agree with Kahn that:

We are eyewitnesses here to the progressive distortion of a documentary account as it passes from hand to hand.⁸³

Where I differ from Kahn is that I see the possibility of this process beginning earlier if the source for Anaximander was an oral tradition, possibly with Aristotle himself, possibly with Theophrastus.

One further thought on the later tradition is the influence of Aristotle's modal argument in relation to cosmogony. Aristotle gives an argument, spanning several chapters of *On the Heavens*, that it is impossible for anything to be both generated and indestructible. Although the issue is controversial, in my view the metaphorical interpretation of Plato's *Timaeus*, that there is no actual cosmogony, was generated to extricate Plato from the perceived difficulty of meeting Aristotle's argument.⁸⁴ To what extent did Aristotle's modal argument then affect the later doxographers in relation to theories where there is the generation of the *cosmos* but no destruction? I do not have an answer to that question, but it is at least a concern that Aristotle tells us that there are people prior to him who thought the *cosmos* generated but imperishable but we find very little of this view in the doxography.

Historiography

As we saw in the first chapter, there are those such as Finkelberg and Engmann who have argued that we should rely on Theophrastus except where there is incontrovertible evidence that we should not.⁸⁵ One possibility here is that Theophrastus did not attribute multiple *cosmoi* (*ouranoi* = rings, *cosmoi* =

civilisations or organised areas) and so was not wrong. Another is that he did attribute multiple *cosmoi* but was wrong to do so. If the latter, I have three sorts of reply to Finkelberg and Engmann. The evidence for a mistake by Theophrastus here derives from Aristotle. I disagree with this historiography. Theophrastus must have been wrong. If I am correct in arguing that Aristotle did not attribute multiple *cosmoi* to Anaximander, then Theophrastus must be wrong. The alternative is that Aristotle was wrong, which, I presume on these criteria, is equally unpalatable.

We surely cannot treat Theophrastus as an unimpeachable source any more than we would Aristotle. Aristotle has well-known weaknesses as a historian of Presocratic thought. Theophrastus clearly shares many of those. Disagreeing with some of Aristotle's evidence casts doubt on the other evidence he gives us, but we are able to cope with that. Similarly, if Theophrastus is wrong in one place, that does not mean we have to cast aside all his evidence. So I do not think it is necessary to show Theophrastus was wrong. I do not even think it is preferable to avoid such interpretations. The evidence does not get better if we ignore its flaws. So I do not hold such strict criteria for impugning Theophrastus as do Engmann and Finkelberg.

Where we have good theoretical grounds for disagreeing with Theophrastus (the nature of Anaximander's thought entails that he has no reason for successive *cosmoi* and has several reasons against), and where we have a parallel for Theophrastus going astray (his treatment of Heraclitus), then it is sufficient to indicate reasonable possibilities for where Theophrastus' error may have sprung from. He may have taken Aristotle's use of *ouranoi* as indicating multiple *cosmoi*, he may have read too much into his comments on the sea drying up or he may have been misled by Aristotle's comment that an infinite heaven means infinite *cosmoi*, applying that to Anaximander.

Finkelberg also raises an important issue, which had previously been raised by Seligman.⁸⁶ The question here is whether we make Anaximander conform 'to our own conception of rational cosmology' at the expense of historical accuracy.⁸⁷ That can be taken in two ways. Out of historical generosity, do we try to see views in Anaximander that can be related to modern views? Apart from the historiographical issues with such an approach, it is indecisive, as modern cosmology countenances all three of the solutions offered for Anaximander. There are theories of a single universe, of successive universes with our universe contracting back down to a singularity after it finishes expanding, and multiple universe (multiverse) theories. All I will say here is the view that I have put forward for Anaximander – that he has a single *cosmos* with a strong steering

principle – is not a view which I would accept about modern cosmogony and cosmology. The second sense here is whether, in trying to give a comprehensive and integrated view of Anaximander, I impose my own sense of rationality on him. That is not my intention; rather I hope to reconstruct Anaximander along the lines of his own sense of rationality. Again, I would stress the views I attribute to him on steering for cosmogony and for zoogony are very different from my own.

Conclusion

As Kahn said back in 1960, it is doubtful that the evidence we have will allow us to come to a decisive conclusion on the number of *cosmoi* in Anaximander.⁸⁸ What I hope to have done here is to produce some new evidence and argument in favour of the Kirk and Kahn line that there is a single, unique *cosmos* for Anaximander. If we take seriously the idea that the *apeiron* steers, and that it is capable of generating a well-ordered *cosmos*, then multiple *cosmoi*, whether successive or co-existent, are otiose for Anaximander. They would have no explanatory role and it is hard to see what would motivate Anaximander to suppose them. I have also argued that, on many grounds, multiple *cosmoi* are conceptually inappropriate for Anaximander. A new argument here is that co-existent *cosmoi* simply do not fit with the equilibrium argument for the stability of the earth and that problem applies to any earth/cosmos in the supposed ensemble. Whether the phrase ‘all of the heavens’ originated with Anaximander or Theophrastus, it does not entail multiple worlds, nor does ‘all the heavens and the *cosmoi* within them’, whether that originated with Anaximander or Theophrastus. Simplest here is that *ouranoi* are the celestial wheels and *cosmoi* are organised areas within them or civilisations on the earth. We can see how the later doxographers, relying on Aristotle and Theophrastus, came to believe that Anaximander had multiple *cosmoi*. In the chapters which follow, I will explore another single *cosmos* argument. This is that Anaximander takes remarkable care in order to set up a stable *cosmos*. This is not just the case for the stability of the earth. Anaximander takes remarkable care in making the heavens stable, both in terms of the individual stability of each of the celestial bodies, and their collective stability. Why is there all this careful work on stability if the *cosmos* is supposed to deteriorate? What is there to cause this supposed deterioration?

The Stability of the *Cosmos*

Anaximander gives us the first model of the heavens in the Greek philosophical tradition. All we have prior to this is Aristotle's report on Thales that the earth rests on water.¹ There has been a debate about the stability of the earth in Anaximander. Is it motionless because of an indifference argument, in the centre of the *cosmos* and not having a preferred direction to move in?² Or is it motionless because it is supported in some way and so prevented from falling, perhaps by a vortex, or by air? I will argue in favour of the consensus, which is that the earth is free floating. I do want to look at the counter-arguments in some detail though, as they inadvertently raise some interesting questions about the stability of other parts of Anaximander's *cosmos*. Usually the issue of the stability of the earth is debated in isolation, but here I argue that this is too narrow a focus, as considerations about the stability of the earth will apply to the wheels of the stars, moon and sun, and the *cosmos* as a whole, if it is surrounded by the *apeiron*. This chapter looks at the stability of the *cosmos*, not just the earth.

I begin by looking at the nature and place of the earth for Anaximander and then at the debate concerning its stability. I examine the equilibrium theory evidence in Plato and Aristotle. I argue that if the earth is thought to be a stone with 3:1 proportions, that very much favours equilibrium theory, the 'supported by air' theory needing something broader. The key new argument I then introduce is whether we can account for the stability of the celestial wheels on anything other than the equilibrium theory, and so too whether we can account for the stability of the *cosmos* relative to the *apeiron*. I then look at the nature of the celestial wheels and the degree of *taxis* and symmetry that Anaximander builds into them. Finally, I look at dynamics. One claim of the 'earth supported by air' theory is that it gives Anaximander a plausible dynamic. I show that this is not the case when we take the stability of the celestial wheels and the *cosmos* into account as well.

There are some important consequences of this discussion. First, it will become evident that Anaximander's *cosmos* has been put together in a very

precise manner, both in terms of the entities which make it up and in their distribution. Anaximander's *cosmos* exhibits a considerable amount of *taxis*. We might then question whether the *cosmos* could have acquired this degree of *taxis* accidentally. If the answer to that is no, then we may have to look to the steering function of the *apeiron* to help explain how the *cosmos* acquired such order. Finally, Anaximander appears to go to great lengths to ensure that the earth, the celestial wheels and the *cosmos* more generally are stable. Why would someone who goes to such lengths then believe that the *cosmos* degenerates and has to be formed anew?

Cosmology

Let us begin by looking at the last part of Anaximander's cosmogony. Pseudo-Plutarch, *Miscellanies* 2 (= Eusebius, *Preparatio Evangelica*, I, 8, 2, DK12A10) tells us that:

What is below us he says is cylindrical in shape and its depth is one third of its width. He says that which is productive out of the eternal hot and cold was separated at the genesis of this *cosmos*, and that a sphere of flame was formed around the air around the earth like the bark around a tree. When this was broken off and enclosed in certain circles, the sun, moon and stars were formed.

The earth, then, has a specific shape, it is cylindrical and the proportions of the cylinder are that its depth is one third of its width. Some have suggested an alternative translation here, whereby the depth of the earth is three times its width. I think the Greek is clear enough that we can settle on the depth as one-third of the width. As Conche and Couprie have argued, τρίτον πρὸς τὸ πλάτος surely means 'a third (part) of the width'.³ A further important consideration raised by Couprie is that while it is common to find stone column drums with a depth one-third of the diameter,⁴ it is rare to find them with a depth of three times the diameter.⁵ I believe the linguistic and the architectural considerations, taken together, to be conclusive here.⁶

The sun, moon and stars are enclosed circles of flame. Why do we see the sun, moon and stars as we do? Stobaeus, I, 24, 1g (= Aetius, II, 13, 7, DK12A18) tells us that:

Concerning what the stars are, their shape, motions and signs.

...

Anaximander, a wheel of compressed air, filled with fire, with flame visible in a certain part through the breathing holes.

So the fire which once surrounded the earth is now broken off and enclosed in wheels of compressed and presumably opaque air. The flame is visible in each wheel through a hole, thus we see the sun, moon and stars as shapes in the sky. As to the relative position of the sun, moon and stars, Pseudo-Plutarch, II, 15, 6 (=Aetius, II, 15, 6, DK12A18) says that:

Concerning the order of the stars.

...

Anaximander, Metordorus of Chios and Krates placed the sun highest of all, after this the moon, then the fixed stars and planets.

This is a slightly odd arrangement for the ancient Greek tradition but the doxography is clear.⁷ Moving inwards to the earth, furthest away we have the sun, then the moon and then nearest to the earth we have the stars. Simplicius, *Commentary on Aristotle's On the Heavens*, 471, 1 credits Anaximander with being first in some of these areas:

Demonstrations have been given concerning the order of the planets, their sizes and their distances, Anaximander having been the first to give an account of their sizes and distances.

One thing we do not have from Anaximander is anything on the five planets that can be seen with the naked eye. That may be because such information has been lost, which might be suggested by Simplicius' comment here. It may be because Anaximander did not distinguish between the planets and the stars, such that the planets are at the same distance as the stars and are part of the same celestial wheel, with the planets moving relative to the fixed stars. The basic outline of cosmology in Anaximander, then, is clear enough. There is a central earth, surrounded by a wheel for the stars, surrounded by a wheel for the moon, surrounded by a wheel for the sun.

Earth stability

There is unanimity in the doxography that for Anaximander the earth is in the centre of the heavens. Theon of Smyrna, 198, 18 (= Heron, *Definitiones*, 138, 11, 6–7) gives the simplest statement here:

Anaximander, that the earth is suspended and lies (κεῖται*) in the centre of the cosmos.⁸

There is no real question that the earth is stationary for Anaximander,⁹ the only significant issue being why the earth remains stationary and at the centre of the *cosmos*. The orthodox view here is that Anaximander employs an indifference argument, that the earth has no reason to move in one direction rather than another and so is stationary. The standard passage here is Aristotle, *On the Heavens*, II/13, 295b11–15 (DK12A26):

There are some, such as Anaximander among the ancients, who say that (the earth) rests on account of its likeness. It is no more fitting that what is established in the centre and has equal relations to the extremes should move up, down or to the side. It is not possible for it to move in opposite directions at the same time, and so necessarily it remains still.

There is also the testimony of Hippolytus, *Refutation of All Heresies*, I, 6, 1–7:

The earth is suspended, not held up in any way, remaining because of the equal distance of everything. Its shape is concave (γυρόν), circular like a stone column drum. One of its surfaces we walk on and there is another surface on the other side.

There is a textual issue here. The old text is ὑγρόν, water, in which case one might translate as Kahn does, ‘the form of the earth was moist’.¹⁰ Kahn defends this text and translation, saying that the view that earth was moist is an authentic Anaximander view such that there is no need here for the change of text. Moreover, if the earth is being described as hollow here, *koilos*, hollow, would be more natural than *gyros*, curved, which might mean convex or concave. Kahn does recognise that if the text is γυρόν, the likely meaning is concave.¹¹

Hahn has argued that column stones were subject to a process call anathurosis whereby the faces were slightly hollowed as an efficient means to make them fit precisely.¹² So, if Anaximander did have a precise analogy with column stones in mind, he might well describe the earth as concave. We do not know if Anaximander supposed both sides of the earth to be concave, but that would seem a strong possibility. That would preserve the symmetry of the earth in the required manner and the indifference argument would still work for its stability. One might also note that there is still a possibility that even if the earth is concave

* The alternative reading is κινεῖται, in which case the earth is in motion around the centre of the cosmos, or Burkert (1972) p. 345 note 38 suggests ἀκίνητος.

in one sense, it is still pill shaped in another. If the earth is concave, water may sit in it as in a saucer. So land is at the same height as the rim of the earth and the earth, with its attendant water, is the usual pill shape.

Opposition

Before we look at the details of this, there are two dissenters from the orthodoxy. Robinson has argued that it is air and a vortex, in conjunction with the uniformity of the earth, which keep it stable. On a possible vortex, Robinson quotes Aristotle, *On the Heavens*, II/13, 295a7, which we looked at in the cosmogony chapter where I rejected a vortex or vortices in Anaximander. Robinson also makes use of the following passage from Simplicius, *Commentary on Aristotle's On the Heavens*, VII, 531, 31–532, 21:

Plato adopts this position when he says in the *Phaedo* that something which is equiposed and is placed in the middle of something homogenous cannot yield to being moved aside in any way. Aristotle, finding that this had been held earlier by Anaximander, found it better to refute him than Plato ... Anaximander believed the earth to be at rest due to the air holding it up and because of its homogeneity and uniformity. Having said he will argue against this view, he (Aristotle) lays out the arguments supporting this view, as usual. It is no more fitting that what is established in the centre and has equal relations to the extremes should move up, down or to the side. It is not possible for it to move in opposite directions at the same time, and so necessarily it remains still.

Robinson's interpretation here is that while air keeps the earth up, there is a need for the earth to be balanced in order that it does not tilt and so become unstable. Simplicius' testimony does not seem entirely consistent on this issue and is not consistent with Aristotle. Simplicius, *Commentary on Aristotle's On the Heavens*, VII, 520, 30–521, 1 tells us that:

Fourthly there are those around Empedocles, who make the heavenly vortex the reason for the earth's stability, and fifthly there are those who say that its uniformity and equipoise are the reason, as with Anaximander and Plato.

That would certainly seem to exclude Anaximander from employing a vortex to keep the earth stationary. As Anaximander is here associated with Plato, it would be odd for Anaximander to have any physical reason for the earth's immobility. To quote Plato, *Phaedo*, 108e–109a7 here:

I am now persuaded that, firstly, if (the earth) is round and in the centre of the heavens, then it requires neither air to prevent it falling nor any other necessitation of this sort, but the uniformity of the heaven itself in every way and the equipoise of the earth itself is sufficient to restrain it. For something which is equipoised and is placed in the middle of something homogenous cannot yield to being moved aside in any way, but in like manner will remain steadfast.

Is this an allusion to, or even a direct report of, Anaximander? This is a distinct possibility and it may be that *Timaeus*, 62d ff., which gives the equipoise argument for the earth again also alludes to Anaximander. It is interesting that Plato uses περιφερής, round, for the shape of the earth here, especially when he has other clear terms he can use to refer to something spherical. Now, I do not want to argue here that Plato in the *Phaedo* attributes a belief in a flat earth to Socrates, or believes in a flat earth himself. On the contrary, I take the earth to be spherical for Socrates/Plato in the *Phaedo* and clear evidence of that is *Phaedo*, 110b:

The earth itself is of such kind to see that, if viewed from above, it resembles a twelve piece leather ball (*sphairai*), decorated with separate colours.

I would also note that at *Phaedo*, 97e, in relation to Anaxagoras, Plato poses the dilemma of πότερον ἢ γῆ πλατεῖα ἐστὶν ἢ στρογγύλη, whether the earth is flat or spherical, the contrast here hardly being that of flat or curved. So I take *Phaedo*, 108e–109a7 to describe a round, flat earth, not requiring air or anything else to support it and to be a report of Anaximander's view. The view of Socrates/Plato in the *Phaedo* is that the earth is spherical and requires no support. Plato is quite aware of the 'vortex' and 'supported by air' theories, though interestingly he differentiates them. *Phaedo*, 99b6–8 says that:

This is why one man surrounds the earth with a vortex, making the earth remain still because of the heavens, while another supports it on a base of air, as though it were a broad kneading trough (καρδόπω).

I do not think Plato has Anaximander in mind here in relation to a vortex or to air (there are other clear possibilities here such as Anaxagoras and Democritus). It is interesting that Plato uses the adjective πλατεῖα, broad, in relation to what is being supported by air. Whether we have quite the right text here with καρδόπω, which usually means 'kneading trough', is certainly open to question. I would consider καρδοπίω, the lid of a kneading trough, as a more plausible alternative in the context of something broad being supported by air. Aristotle, as we shall see in our next passage, specifically mentions a lid in this sort of context. In either case, the key thing is that Plato sees that if you are going to have something

supported by air, it needs to be broad. Note, though, that there is no mention of breadth at Plato, *Phaedo*, 108e–109a7.

Earth stability: shape or size?

In relation to this, Aristotle sees the same point at *De Caelo*, 294b13–30:

Anaximenes, Anaxagoras and Democritus say that it is the breadth of the earth that is the reason for its immobility. It does not cut, but covers the air below it like a lid, as it seems that broad bodies have this ability. Even winds find them hard to move due to this resistance. This same effect, they say, is produced by the breadth of the earth in relation to the underlying air, which not having sufficient room to change place rests on the mass below, like with the case of the clepsydra and water. They cite many proofs that air, when cut off and at rest, has the ability to carry much weight.

Firstly, if the earth is not broad, this cannot be the reason for its stability. Moreover in their account it is not the breadth that is the reason for stability, but rather the size. The reason why the air is closely confined and has no way out and so remains where it is, is that there is a great amount of it. This will be the case, even if the earth is spherical, as long as it is of great size. According to their arguments, it remains where it is.

Throughout this passage I have translated *platos* and its cognates as ‘broad’ or ‘breadth’ (the primary meaning) rather than as ‘flat’, as I think this makes better sense of the argument. I do not doubt that Anaximenes, Anaxagoras and Democritus did advocate a flat earth but, as Aristotle points out, the key issue is significant breadth if that earth is going to be supported by air. An important point about this passage is that if Aristotle believes that Anaximander thought the earth was broad, or was supported by air, here is his perfect chance to say so. He has just told us that Thales believed the earth to float on water, this being the earliest account being given of this type and here we have the view of Anaximenes.

Anaximander’s earth

There is a further strong objection to the ‘supported by air’ view. We are told in several sources that Anaximander’s conception of the earth is like a section of a stone column, e.g. Pseudo-Plutarch, III, 10, 2:¹³

Concerning the shape of the earth.

...

Anaximander, the earth is similar to a stone column. The surface . . .

It seems to me that this is a singularly inappropriate comparison if one wants to suggest that the earth is held up by air. To put it bluntly, a stone column would sink; everyone would immediately recognise that they are extremely heavy and difficult to support. One would expect something that one could at least conceive of as supported by air, while this looks the very antithesis (e.g. compare Aristotle's report on Thales where the earth floats on water 'like a piece of wood'). One might also consider the proportions Anaximander gives to the earth. For it to be supported by air, one might expect a much greater width-to-depth ratio than 3:1,¹⁴ and while Aristotle at *De Caelo*, II/13, 294b14 ff. has Anaximenes, Anaxagoras and Democritus all emphasising the great size of the earth such that it can trap air beneath it, we find nothing of this sort in Anaximander. This is despite the fact that while there were 3:1 column stones, there were also column stones with a greater width-to-depth ratio. On the other hand, if the argument is an indifference one, then this seems a very good analogy. It does not matter how heavy the object is, what matters is that it has no preferred direction to move in. It is also significant here that when Plato refers to someone who has the earth supported on a base of air in the *Phaedo*, the earth is like something broad, an eminently reasonable analogy. Finally, when Hesiod gives the dimensions of his world, he does so using a bronze anvil which falls for nine days from heaven, reaching the earth on the tenth.¹⁵ Why does Hesiod choose an anvil? Presumably, because it is something that will fall very quickly and will not be stopped. Against that background, a column stone would also seem to be something which will fall quickly and will not be prevented from doing so. Thus an indifference argument would seem appropriate rather than a supported by air argument.

One further aspect of the column stone analogy. What are column stones supported by? In parallel with the famed tale of the reply to the cosmologist's lecture, where the answer from the audience on what supports the earth was 'it is turtles all the way down', the answer would be it is column stones all the way down.¹⁶ It is remarkable that Anaximander breaks with any 'it is x all the way down' explanation using an analogy for the earth which invites an 'all the way down' treatment (column stones all the way down) but then asserts that the earth is unsupported and does not move due to indifference. This is a remarkable transformation from the architectural influences.

Earth at the centre of?

The second dissenter from the orthodox view is Furley, who, quite properly, pushes the question of what the earth is at the centre of.¹⁷ According to Furley, when Aristotle speaks of 'equal relations to the extremes', that can only be a reference to Anaximander's rings.¹⁸ The question then is why the existence of these rings would in any way affect the stability or motion of the earth.¹⁹

I have several differences with Furley here. First, the Greek translated here as 'extreme' is *eschata*, which, when used spatially, is usually rendered farthest, uttermost or extreme and generally has a sense of utmost or last. It is then plausible that the reference is to the extremes of space, if we allow the *apeiron* to be spatially unlimited yet finite. If Anaximander's *cosmos* is spherical, then it is contained within something spherical and homogenous and indeed will have no reason to move in any direction. One further issue in relation to *eschata* is that surely it either means the *apeiron*, or the ring of the sun, as the outermost ring of the *cosmos*. On either account it seems we are asked to ignore what is going on with the rings of the stars and of the moon.

My second disagreement with Furley is that if it is the rings that are referred to here, there is a way in which that matters for the stability of the earth. I very much doubt that Anaximander's argument here is physical, in the sense that the earth stays still because there is an equal balance of forces. In general, I doubt that the Presocratics had the idea of attractive or repulsive forces. The like-for-like principle, where invoked, works in a different way to forces.²⁰ I see no trace of either attractive/repulsive forces in Anaximander or the like-for-like principle. I take this to be a philosophical indifference argument based on the principle of sufficient reason. Then it does matter what is in each direction.

Aristotle and the *Phaedo*

Furley argues that Aristotle, *On the Heavens*, II/13, 295b11–15 (DK12A26), depends on the passage at Plato's *Phaedo*, 108e–109a7, which we looked at in the last section. Furley says that:

The verbal parallels are too close to be accidental.²¹

On this issue I am inclined to agree with Furley. The verbal parallels are very strong.²² As I have indicated earlier, I am open to the idea that Aristotle did not

have the text of Anaximander's work in front of him and may well rely on Plato for his report. However, my disagreement with Furley relates to how we look at the *Phaedo* passage. Furley says that:

Who was the 'someone' who persuaded Socrates? Not Anaximander, certainly. Plato never mentions or otherwise alludes to Anaximander.²³

It is possible that Plato makes one and only one allusion to Anaximander and it is here in the *Phaedo*. However, I have argued that Plato does make other allusions to Anaximander, so this may be part of a pattern. I am not concerned whether (the historical) Socrates or Plato may have been persuaded either by reading some Anaximander or hearing someone else give his arguments. A crucial question must be why does Aristotle mention Anaximander in this passage? On my account, this is straightforward. The *Phaedo* passage alludes to Anaximander, something which Aristotle recognises and then refers to more explicitly in his own passage in *De Caelo*. Simplicius' account at *Commentary on Aristotle's On the Heavens*, VII, 531, 31–532, 21, where he mentions air as well as equilibrium, on my view is confused. To make the question more pointed, why does Aristotle mention Anaximander in this particular passage, when there are other passages, where he discusses a 'supported by air' theory, where he does not mention Anaximander, instead mentioning Anaximenes and Thales?

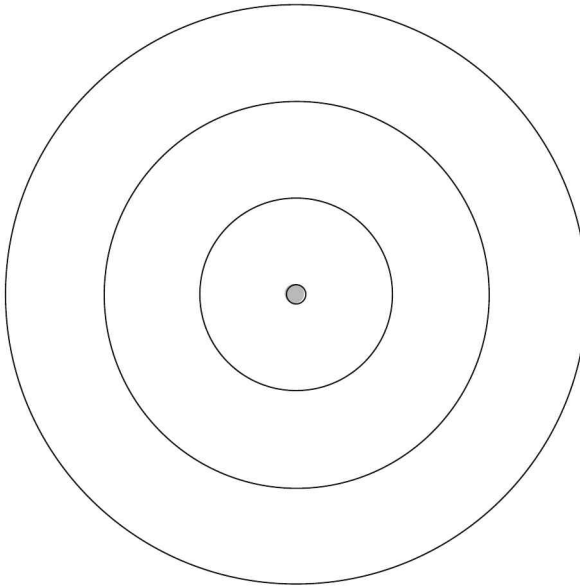
Wheel stability

There is an important question for Anaximander's cosmology which is not often addressed but can be put very simply. The earth is not the only physical entity in Anaximander's *cosmos*. There are also the celestial wheels for the stars, sun and moon, made of compressed air and fire. Why are these stable relative to the earth?²⁴ Why do they not drop, if we are worried about the earth dropping? Why do they not rise, if they are made of fire and air? Or why do they not simply wander off to another part of the *cosmos* or *apeiron*? I take it that the celestial wheels are stable and that is an important fact to be accounted for in any description of Anaximander's cosmology.²⁵

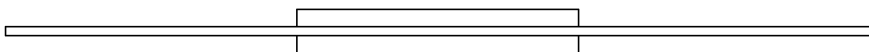
Could the celestial wheels stay in position because they are supported by air? The answer to this has to be a conclusive no. They are the wrong shape and perhaps more critically, the wrong orientation. We might debate whether it is plausible that a wheel rim could be supported by air in the same way that a

continuous disc is supposed to be, in the 'earth is supported by air' theory. One objection to this would be that the wheel rims cannot be considered to be 'broad' in any account of them; this breadth seems to be critical for the idea that celestial objects could be supported by air.

The wheels also have the wrong orientation, which is only brought out if we think more broadly about Anaximander's cosmology. The simplest depiction of his cosmology is usually like this:



As a means of depicting the order of earth, stars, moon and sun this is fine, but it is easy to gain the impression that the wheels are all in the plane of the earth and so are at right angles to the supposed direction of fall in Anaximander's *cosmos*. This would have the unfortunate consequence that the stars, moon and sun would only ever be seen very close to the horizon. If we turn this depiction through 90 degrees, from plan to elevation view, we get something like this:



We have our central earth surrounded by a wheel, whether it be the wheel of the stars, moon or sun. The sun and moon can go around their wheels but will never be seen other than on the horizon by any observer on earth.

There is evidence, though, that the wheels are angled relative to the earth's surface, rather than in the same plane. Stobaeus, I, 26, 1a tells us that:

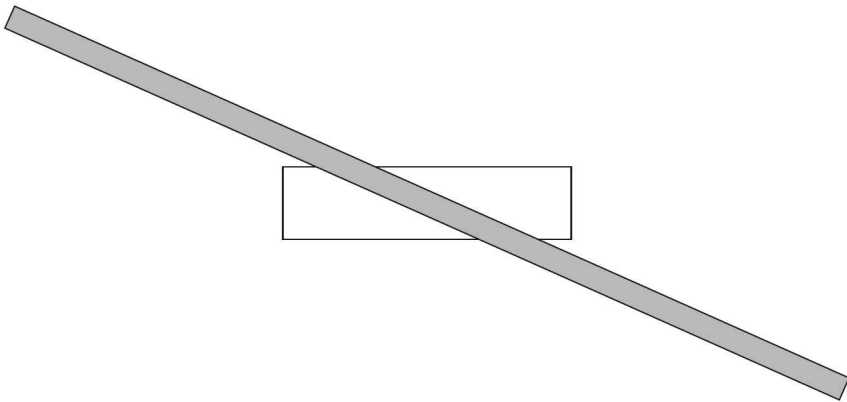
Concerning what the moon is, its size and shape, its light, and concerning eclipses and appearances, and concerning distances and signs.

Anaximander, it is a circle nineteen times that of the earth, like the wheel of a wagon, with a hollow rim full of fire, like that of the sun, lying angled, as with the sun, having a single aperture like the nozzle of a bellows. Eclipses occur with the turning of the wheel.

What we do not know, however, is any value for the angle here. It is unlikely that the angling of the wheels for the sun and moon has anything to do with knowledge of the ecliptic. Pliny, *Natural History*, II, 31 tells us that:

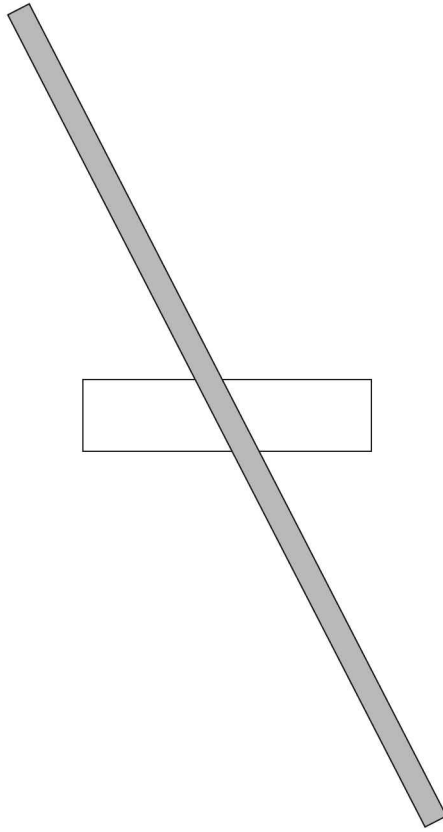
The obliquity (of the zodiac) was discovered, opening the door to the understanding of the topic, traditionally first by Anaximander of Miletus, in the 58th Olympiad. Afterwards Cleostratus made the signs in it, firstly those of Aries and Sagittarius, Atlas formed the sphere long before.

This is universally held to be overly optimistic. What the angling of the wheels for the moon and sun will do is give the moon and sun reasonable altitude in the sky as they pass over the earth. Pliny probably confuses this with later accounts of the ecliptic. This is again significant in relation to the stability of the wheels. One might have the picture of the wheels being offset by the angle of the ecliptic, as in some later cosmologies, giving a picture something like this:



However, if as seems likely, the angling of the wheels is done to give the sun and moon a reasonable path across the sky, then the angle relative to the earth's plane needs to be greater. Here, the sun and moon would appear too

low in the sky. So something more like the following diagram might be more appropriate.



This would give a more reasonable path for the moon and sun across the sky. However, it should now be obvious that the wheels cannot be stable in the sense that Furley supposes the earth to be stable. They are not at right angles to the direction of fall, indeed on the most likely account of their angling they have quite an extreme angle to the direction of fall. They simply cannot be supported by air. One might counter that we do not know what angle Anaximander supposed for the moon and sun wheels. That is true and we have to supply other criteria in hypothetical reconstructions. Any angling will disrupt the sort of equilibrium for the wheels that Furley supposes for the earth. The most plausible reconstruction gives a quite extreme angle. The orientation of the wheels relative to the plane of the earth means that we cannot have both the earth and the rings supported by air. There is a simple dilemma here. If we accept that the wheels of

the moon and sun are angled relative to the plane of the earth, then either the earth is not at right angles to the line of fall or the wheels are not at right angles to the line of fall.

Could the celestial wheels stay in position because air and fire rise? The answer to this has to be a conclusive no. The continual rise of air and fire can be thought of in both parallel and centrifocal terms. In terms of a parallel cosmology, air and fire would simply move upwards against the direction of fall of heavy bodies, presumably in perpetuity, depending on whether Anaximander's *apeiron* is thought to be spatially infinite or not. Similarly, air and fire would simply move outwards from the centre ('rise'), again presumably in perpetuity, depending on whether or not Anaximander's *apeiron* is thought to be spatially infinite. It is debatable whether there is any effective barrier for the *cosmos* in Anaximander, which would prevent air and fire rising continually. One might argue that as the *apeiron* surrounds the *cosmos*, it prevents any part of it from straying outside certain bounds. If there were such a boundary, then air and fire would not stay in well-organised celestial wheels but would rise, either upwards or outwards to the limit of the *cosmos*. There would be no spacing of the wheels for the stars, moon and sun. In a sense this is trivial, but it does have some important cosmological and cosmogonical consequences. We cannot explain why the sun is the brightest body just in terms of fire rising, as then there would be only the sun and not the moon and stars as well. Something must distribute fire in the heavens, it cannot simply collect at the highest/furthest point. Nor can it be the case that the celestial wheels form through fire and air rising, as again we would not get the necessary differentiation.

Could the celestial wheels stay in position because, like the earth, they are equipoised and have no preferred direction to move in? This would seem to be the only remaining possibility and one that is strongly supported by the numbers that Anaximander uses for the proportions of the *cosmos*. Let us start by considering the star wheel. If it is circular and centred on the earth, then it will be in equilibrium.

Next, let us bring in the moon wheel. It, too, is circular and centred on the earth; the star wheel is half way between the earth and the moon wheel. The moon wheel has no reason to move in or move out. Finally, let us consider the sun wheel. It too is circular and centred on the earth. As the outermost wheel, of necessity it has wheels inside it but not outside it. However, the *apeiron* outside the sun wheel is uniform, so the sun wheel will have no preferred direction of motion. Alternatively, there is West's suggestion that the sequence 9, 18, 27 should be finished with 36 as the distance to the edge of the *cosmos* or *apeiron*. The sun

would then be equally placed between the moon wheel and the limit of the *cosmos* or the *apeiron*.²⁶

If one looks a little more deeply here, there are questions to be asked about this supposed stability. Is the circularity of the wheels enough? With a set of concentric circles there would be no tendency for the circles to distort in any manner, if they are all in one plane. Does the fact that they are likely to be in different planes, to give the sun and moon appropriate elevation as they cross the sky, alter that? There might be a tendency, even with concentric circles in one plane, for a circle to become larger or smaller, if its adjacent circles are not equidistant. Anaximander appears to have this covered with the 9, 18, 27 sequence, though there will always be a question about the first and last members of the sequences. Is the distance from the earth to the star wheel and the relationship between them adequate for stability? Even if we take into account that the wheels will not all be in the same plane? Is the relation between the sun wheel and what is outside it adequate for stability?

Equidistance

One issue with Anaximander's view has been that the earth is pill shaped, and so cannot be equidistant from the extremes in all directions. If we take the wheels of the moon and the sun to be slanted, then this problem is exacerbated. With the simplest model of Anaximander's *cosmos*, with wheels in the same plane as the flat surfaces of the earth, it is easy to see that the earth is indeed equidistant from the extremes if we are taking the wheels as the extremes. However, if the earth is shaped like a section of a drum and the wheels of the moon and sun are slanted, can the earth be equidistant in the required way? First, there is an issue of translation in Aristotle's report. It is best to translate this literally, so *καὶ ὁμοίως πρὸς τὰ ἔσχατα ἔχον* should be rendered 'has equal relations to the extremes'. The other testimony here is Hippolytus, *Refutation of All Heresies*, I, 6, 1–7, μένουσαν δὲ διὰ τὴν ὁμοίαν πάντων ἀπόστασιν, 'remaining because of the equal distance of everything'. The advantage of this is that one can then argue that equidistance is not the issue here, but symmetry is. If the earth is pill shaped and in the centre, then it has the necessary symmetry for an indifference argument to work, if it is placed in something spherical. Every direction is equally related to the extremes in the opposite direction.

Second, as long as the sun ring is circular and has the same centre as the earth, this also works for the relation of the earth and the sun. The symmetry is such

that there is no preferred direction for the earth to move in. A small caveat here. If we consider this in terms of force (which we should not), a ring which is not in the plane of the earth's surface or at right angles to it will exert a turning moment on the earth, causing it to rotate.

Wheel formation

I argue that not only are the celestial wheels well positioned in Anaximander, they also have a complex structure, such that they might be considered to be *ouranoi* in themselves, entities made up from several components in a good order. The question I am interested in here is this: could these celestial wheels have come into being accidentally, or through any straightforward physical process used by Anaximander or known to early Greek thought? So, for instance, could the wheels have formed because of the tendency of air and fire to rise, as we often find in Greek thought? If this were Aristotle, and we were explaining why air and fire are at the periphery of the terrestrial realm, then this might be an adequate explanation. However, the celestial wheels, taken both individually and together, have specific position and significant structure that cannot be explained simply by air and fire rising. One small but important point in relation to this is that if the fiery cores of the wheels are surrounded by air, the outermost element for Anaximander is air, not fire.

Cosmos stability

In the previous section, I argued that the question of the stability of the earth must be seen in a wider context, that of the stability of the celestial wheels. We must now consider a further more general question, that of the relation of the *cosmos* to the *apeiron*. I take it as uncontested that the *cosmos* is surrounded by the *apeiron*. An interesting question to ask now is, if a parallel dynamics applies to the *cosmos*, does it also apply to the *apeiron*? Neither alternative looks plausible.

Let us suppose that the *apeiron* is included in the parallel dynamics. Is there anything to prevent the fall of the *cosmos*? An important objection here is that Anaximander is not Epicurus and we would expect some trace of such a radical view to have been preserved. An important philosophical consideration here is that to give a direction of fall in the *apeiron* would be to give it a significant characteristic, which looks implausible. One might also ask, in the manner of

Leibniz in the Leibniz-Clarke correspondence, which direction of fall? If the *apeiron* is homogenous, what reason would there be for a specific direction of fall? Does having a direction of fall violate the nature of the *apeiron*, giving it a specific characteristic when it is not supposed to have one? One might reply that Epicurus sidesteps this issue to have a specific direction of fall, but Epicurus is much later and has a very different conception of space.

Let us suppose, then, that the *apeiron* is not included in the parallel dynamics. There must then be a boundary between the *cosmos* and the *apeiron* where the parallel dynamics stops. Is there then some celestial junk yard, at the bottom of the *cosmos*, gradually filling up with Hesiod's bronze anvils or anything else that is in free fall? Clearly not, but if there is a boundary between the *cosmos* and the *apeiron* in the sense of somewhere that free fall motion ends, then there must be such a place.

We might also ask the question, if the *cosmos* is surrounded by the *apeiron*, why does it not have motion relative to the *apeiron*? It would seem that either the *cosmos*, and the earth with it, is in motion or that the *cosmos* does not move within the *apeiron*. The latter would seem to be a matter of indifference. In which direction would the *cosmos* move within the *apeiron*? Anaximander may be a more radical thinker than Furley supposed. Not only is the earth unsupported and subject to an indifference argument in the *cosmos*, but the *cosmos* is unsupported and subject to an indifference argument within the *apeiron*.

The wheel apertures

What did Anaximander think about the sun? Pseudo-Plutarch, II, 20, 1 tells us that:²⁷

Anaximander, the sun is a circle twenty-eight times the size of the earth, like the wheel of a wagon, with a hollow rim, full of fire, at a specific point revealing the fire through an aperture as with a stream of *prêstêr*. This is the sun.

We have similar information about the moon.²⁸ What is the nature of the gaps in the compressed air through which we see the sun and moon? I have translated 'aperture' as in my view these are simple circular holes; these can be occluded to generate eclipses and phases of the moon, in a manner analogous to the shutter of a camera. That I think is a reasonable description of them, though if that is felt to be anachronistic or too mechanical, 'breathing hole', a direct translation of *ἐκπνοή*, would do instead. There has been some debate here though. In the case

of the moon, I have translated Stobaeus, I, 26, 1a, οἶον πρηστῆρος αὐλόν as 'like a stream of *prêstêr*' where there is an alternative translation of 'like the nozzle of a bellows'. In the case of the sun, I have translated Pseudo-Plutarch, II, 20, 1, ὥσπερ διὰ πρηστῆρος αὐλοῦ 'as with a stream of *prêstêr*'²⁹ where there is an alternative translation of 'as through the nozzle of a bellows'.³⁰ One issue here is whether the holes in the compressed air rings are simply that, holes, or whether they are like nozzles, tubes or even the spokes of a wheel.

The first thing to say is that in other places, these gaps are simply described as ἐκπνοή, a vent or breathing hole,³¹ or στόμιον, a mouth.³² If these were the only descriptions we have, I don't think we would have any problem at all. There would simply be a circular gap in the compressed air through which we see the fire inside. Now we have to consider whether these gaps are in fact nozzles/tubes/spokes or whether we have simple gaps with the phrase οἶον πρηστῆρος αὐλόν telling us something more about the nature of the gap.

One concern with the nozzle/tube/spoke view would be that this would spoil the symmetry of the tubes and would undermine the indifference argument for the stability of the earth and of the rings themselves. One can accept the 'like the nozzle of a bellows' translation without that implication though. What one might take from it is that the nozzle of a bellows is circular and it emits air. So the gaps in the ring of compressed air are circular and emit light, with no need for a nozzle. It is hard to see what a nozzle would add to Anaximander's picture of the heavens. Perhaps it would direct light at the earth where a simple gap would allow light to spread around the rest of the heavens, but there is no pressing need for Anaximander to exclude that possibility.

As Couprie had pointed out though, the standard Greek term for bellows is *phusa*, so if bellows is meant, it is odd he did not use that term. *prêstêr* is a term we have come across before with Anaximander, with his meteorology.³³ There I rendered it 'hurricane' but it can also mean 'hurricane or waterspout attended with lightning'.³⁴ While *aulos* can mean nozzle, pipe or tube, it can also mean stream or jet. The advantage of this translation is that it links Anaximander's cosmology to his meteorology. Just as a *prêstêr* emerges from a small hole in cloud, so here we have light emerging from a small hole in the compressed air ring. Instead of this being a single emergence, we have a stream.³⁵ So where in the meteorology we get a single flash when a hole is made in a cloud, here we have a permanent stream of light coming from the fire inside the compressed air ring. I doubt that this view can be conclusively established but it does provide an interesting perspective which emphasises the coherence of Anaximander's thought. Light makes no noise, unlike lightning, as light is a permanent flow

through a permanent hole, while the noise for lightning comes from the new rent in a cloud.

Personally, I like the idea of treating *prêstêr* in this context in a meteorological fashion. It links the cosmology and the meteorology very nicely and avoids the unnecessary complication of the compressed air wheels not being symmetrical. I also think it sits well with ἐκπνοή if we are taking that to be a vent or breathing hole, with the other sense of ἐκπνοή being a breathing out or exhalation.³⁶ If the origin for this is animals, then they have simple mouths to breathe through rather than extended pipes. The notion of something flowing through an ἐκπνοή, analogous to wind, also works well. I also think there are interesting things to say here about the way that Anaximander uses natural explanations for the heavens and generates an account of invariant light from the explanation of a flash of lightning.

However, this interpretation is not free from difficulties. Let us go back to Pseudo-Plutarch, II, 20, 1. If we extract πρηστήρος αὐλοῦ from its sentence, it is possible to give that a meaning other than ‘nozzle of a bellows’. If we put it back in its sentence with the new meaning, there is a problem. So: διὰ στομίῳ τὸ πῦρ ὥσπερ διὰ πρηστήρος αὐλοῦ. The issue here is the διὰ pair. The natural reading of the first διὰ is ‘through’, so ‘through a mouth’, so one would expect the second διὰ to have the same sense, but ‘through a stream of *prêstêr*’ does not seem to make good sense. There are two possibilities here. We take the second διὰ to have a different sense from the first. So ‘through a mouth just as with a stream of *prêstêr*’ makes more sense. In favour of this view, as Couprie has argued, is the fact that this seems to be the way that the Arabic tradition translated this sentence.³⁷ The second possibility is that we have two relevant passages, one from Stobaeus on the moon and one from Pseudo-Plutarch on the sun. Pseudo-Plutarch gives us ὥσπερ διὰ πρηστήρος αὐλοῦ, while Stobaeus gives us οἷον πρηστήρος αὐλόν. We might take the Stobaeus phrase to be more authentic and the Pseudo-Plutarch one as a slightly garbled account.³⁸

There is some further information on this issue, given to us by Achilles Tatius. This is sometimes ignored, as Achilles is not thought to be a good witness, his account being thought to be a garbled version of other, clearer accounts.³⁹ It is worth looking at though, if only to clarify some issues. So Achilles Tatius, *Isagoge*, 19, 16–23 (DK12A21) says that:

Concerning the sun.

...

Some, of whom there is Anaximander, say it is to send light, having the form of a wheel. For as in a wheel where there is a hollow hub, spokes radiate outwards

to the rim, such that from the hollow, light is made to be sent out though the spokes as rays, and these shine outside in a circle. Some say that, as with a trumpet, it sends out light through a narrow hole, like a nozzle/stream of air (ὥσπερ πρηστήρας).

Achilles takes the wheel analogy strongly, and here there are spokes to the wheel as well. That, I suggest, is an attempt to solve a problem in Anaximander. If the compressed air is opaque, which it has to be to conceal the fire, then how is it that we have an uninterrupted view of the moon and the sun, which are beyond the ring of the stars? Later on I will suggest that is not a problem for Anaximander, but if Achilles perceives that to be a problem, then one solution is to have spokes to the celestial wheels and for light to be transmitted down those spokes. I do not think that is a great solution, but it might be why Achilles refers to spokes where no-one else has. Here too we get mention of a trumpet, which might suggest a pipe down which something travels. So the spokes are not original to Anaximander, but are Achilles' attempt to save Anaximander from a perceived problem. The final sentence here is not so much of a worry, if we treat trumpet in the same way as we treated 'nozzle of a bellows' earlier. As long as all is meant is that the hole is circular, as with a trumpet, and light is expelled as a trumpet expels air, there is no problem.

The final piece of evidence here is Hippolytus, *Refutation of All Heresies*, I, 6, 1–7 (DK12A11):

The stars were generated as circles of fire, separated off from cosmic fire, surrounded by air. There are some tubelike passages for breathing holes, through which the stars appear. So when the apertures are blocked eclipses occur. The moon appears to be waxing or waning in turns due to whether the apertures are opening or closing. The circle of the sun is twenty-seven times that of the earth and eighteen times that of the moon. The sun is the highest body, the lowest is the circle of the fixed stars.

However, there is a textual alternative at the critical point here. Diels prints:

Ἐκπνοὰς δ' ὑπάρξαι πόρους τινὰς αὐλώδεις, καθ' οὓς φαίνεται τὰ ἄστρο·

The alternative text is:

Ἐκπνοὰς δ' ὑπάρξαι τόπους τινὰς αερώδεις, καθ' οὓς φαίνεται τὰ ἄστρο·⁴⁰

If we adopt the alternative text, then all Hippolytus is telling us is that there are mouths at certain places through which the stars appear.

There is no simple answer to what is meant by πρηστήρος αὐλός in Anaximander. Even if we go for the older view of 'the nozzle of a bellows' there

is a way of taking that as a description of simple apertures (round, something come out of them) rather than tubes or pipes. If we can interpret *πρηστῆρος* here in meteorological terms, there are some interesting consequences for the coherence of Anaximander's views. Which options we take are going to be governed by higher level historiographical decisions about what sort of Anaximander we want.

Minor variations and stability

We might accept that if the earth is equipoised and has appropriate relations to what is around it, it has no reason to move in one direction rather than another. There are, though, two worries about this ideal scenario. The first is that while this may be true of the earth at the macro scale, at the micro scale it is false. So to put this in modern terms for simplicity, on a macro scale the earth might be considered to be a sphere. In fact it is not, it is an oblate spheroid. At a smaller scale the earth's surface is not that of a sphere (mountains and valleys) and at an even smaller scale there are human beings and other animals who not only spoil the symmetry but also fail to keep still. Some of this matters for the motion of the earth, some does not. It does matter that the earth is an oblate spheroid, as this is part of the reason that the earth 'wobbles' on its axis and we see the effect known as the precession of the equinoxes. That the earth has mountains and valleys is not significant, nor is animal life.

It is worth noting that Anaximander's geography, so far as we can reconstruct it, shows a remarkable amount of symmetry. Herodotus says that:

I laugh when I see that many have drawn a map of the earth up to now, as none of them have expounded this intelligently. They draw Okeanos flowing around the earth, which is made circular as with a compass, and Asia is made equal to Europe.⁴¹

If that report is derived from Anaximander, it is interesting to note the precision of the circle and that the land masses of Asia and Europe are equal to one another.⁴² The view I would ascribe to Anaximander is that as long as the earth has the appropriate symmetry on a macro scale, the rest makes no practical difference to the stability of the earth.

The second issue here is the nature of the wheels the earth sits within. Here Bodnar has made a very important point that Anaximander could not conceive of the celestial bodies in the way that we do, as massive free-floating spheres, as their

distribution would immediately give the earth a reason to move in one direction.⁴³ So we have the celestial wheels giving the required symmetry for the stability of the earth. There has to be a caveat though, similar to that considered for the earth. The celestial wheels cannot be entirely homogenous, as each wheel has to have an aperture, or as is likely for the star wheel(s), several apertures. The indifference argument for the stability of the earth, and for the stability of the wheels themselves, coheres best with the wheels being as homogenous as possible, so the aperture view works better here than a view where the openings are tubes, arranged like the valve on a bicycle tyre, say. Of course there has to be some inhomogeneity in order for the celestial body to have a specific location, hence the aperture. I would suggest, though, that for practical purposes this does not compromise either the stability of the celestial wheels or the stability of the earth.⁴⁴

We might also ask an important question here. Why celestial wheels? Anaximander is, as far as we are aware, unique in holding this view. That there are such wheels, rather than heavenly bodies in the usual sense, gives the *cosmos* the symmetry it requires for stability. These wheels are simply not required on the supported by vortex or supported by air views of the earth in Anaximander. It is possible to argue that these wheels have as much symmetry as Anaximander could work into them, given that the aperture in them must be at some specific location.

Dynamics

One major advantage of Furley's account is that it gives Anaximander a plausible dynamics, at least at first sight. Furley distinguishes between two types of cosmological dynamics. There are parallel cosmologies, where heavy objects fall from the top of the *cosmos* to the bottom, as with Hesiod and an anvil dropping from heaven to earth, and then from earth to Tartarus. Alternatively, there are centrifocal cosmologies, where heavy objects move towards a central point, the canonical example here being Aristotle.

If all bodies fall in straight lines, and the earth is supported, it is easy to see why we humans and other material objects fall to the ground and do so perpendicular to the surface of the earth. What is more, that explanation will work at all parts of the earth's surface. If we attempt to give a centrifocal account of dynamics with a flat earth, this may work reasonably well close to the centre of the earth's surface, where the line of fall will be close to perpendicular to the earth's surface, but will fail badly at anywhere near the rim of the earth where the line of fall will be much closer to parallel to the earth's surface. Conversely, a

parallel dynamics and a spherical earth will give you the correct result at the 'north' pole but will have objects moving parallel to the earth's surface at the equator. So Furley argues that a spherical earth is appropriate for a centrifocal cosmology, while a flat earth is appropriate for a parallel cosmology.⁴⁵ As Anaximander clearly advocates a flat earth, then a parallel dynamics seems appropriate and, as we have seen, Furley has proposed that the earth does not fall because it is supported by air.⁴⁶ The really pertinent question for Anaximander, if he does explain the earth's lack of motion in terms of indifference, is why objects on the earth fall to the ground and why we humans stick to the earth.

Furley's proposal of an earth supported by air in Anaximander is in one sense attractive, as it appears to give Anaximander a plausible dynamics. However, this is illusory. The proposed dynamics will not account for the stability of the celestial wheels and the earth in Anaximander, nor of the *cosmos*. I do not have a positive account of a dynamics to go with the indifference theory. Why objects fall for Anaximander remains an open question. It may be that Anaximander's thought on this issue is lost. I disagree with Furley's comment that:

It follows that if this whole theory is to be attributed to Anaximander, including the proposition that the earth needs no underpropping, we must attribute to him some kind of centrifocal dynamics as well.⁴⁷

It may be that this was not a question which concerned Anaximander greatly, or at least not as much as Furley has suggested. In the *Phaedo*, there is a spherical earth but no centrifocal dynamics. Only later in the *Timaeus* does Plato formulate something approaching a centrifocal dynamics. Whether or not Plato had a centrifocal dynamics at the time of writing the *Phaedo*, it is not to be found there explicitly. Anaximander may not have spoken of the shape of the earth in contexts which required him to think about a dynamics (as with Plato in the *Phaedo*) and there are possibilities other than a straightforward centrifocal dynamics. I agree with McKirahan that Furley demands too much of Anaximander by insisting he had a theory of dynamics.⁴⁸ Was Anaximander's indifference theory remarkable for its time? Furley has also commented that:

Such a theory at the time of Anaximander would be even more remarkable than has usually been supposed.⁴⁹

For Furley, the indifference theory is bound up with the centrifocal theory. While I do not think that Anaximander had a centrifocal theory, I do find his account of the cosmos more remarkable than has usually been supposed. It is not only the earth which stays in position due to an indifference argument, but the

celestial wheels and the *cosmos* itself within the surrounding *apeiron*. Sometimes people come up with remarkable ideas though. I would cite the *apeiron* itself as a remarkable idea. Is it the case, as KRS say, that Anaximander's:

Theory of equilibrium was a brilliant leap into the realms of the mathematical and the a priori.⁵⁰

If we consider Anaximander's model of the heavens to be purely concerned with astronomy, that may well be so. However, in the next couple of chapters I will suggest that there may have been other motivations for and influences on his model of the heavens that make the stability of the earth less of a conceptual leap and that dynamics may not have been a central concern for Anaximander.

Conclusion

The stability of the earth in Anaximander is a well-worn topic but I hope to have introduced some interesting new considerations here, looking beyond the question of the earth taken in isolation. In Anaximander, the earth is in the centre of the *cosmos* and is unsupported. It does not move because there is no preferred direction for it to move in. There is no vortex in Anaximander to support the earth from falling. It cannot be the case that both the earth and the celestial wheels are supported by air. The notion of a parallel cosmology, which may well be applicable to Homer, Hesiod and Thales, does not make sense for Anaximander. The *cosmos*, if it is surrounded by the *apeiron*, would also seem to be subject to an indifference argument, as there can be no specific direction for it to move in within the *apeiron*. Doubtless this is radical and remarkable thinking, but then so is the very concept of the *apeiron* in the first place.

I am unconcerned that after Anaximander, Anaximenes wants his earth supported by air, any more than I would be concerned that Anaximander proposed air as the key element after Anaximander on the *apeiron*. I do not subscribe to a linear view of the history of science or philosophy such that each successive thinker must improve on his predecessors. Anaximenes had many other interesting things to say.

To return to some themes outlined in the introduction to this chapter, it is clear that the celestial wheels have considerable *taxis* both in terms of placement and structure. They might well have been termed *ouranoi* by either Anaximander or Aristotle. The choice of circles for the shape of those wheels and their specific

placing seems intended to ensure the stability of the heavens, giving the wheels no particular direction to move in. Why would anyone going to these lengths to establish complete stability, not only of the earth but of the celestial wheels and of the *cosmos* as whole, then want to have a *cosmos* which deteriorates? Could a *cosmos* which exhibits such *taxis*, such specific placement and structure come about by chance or by unguided physical/mechanical processes?

Anaximander's Cosmology and Astronomy

The title of this chapter may seem a little fussy and pedantic, mentioning both cosmology and astronomy, but there is both a reason for this and for mentioning them in this order. With early Greek models of the *cosmos*, we can reconstruct them such that the cosmological principles behind them remain strong and consistent, or we can reconstruct them such that they account for the maximum possible number of phenomena. It would be nice if those approaches gave the same result every time, but they do not. I want to explore the tension between cosmology and astronomy, whereby reconstructions of a model of the heavens may be strong on cosmological principle but weaker on astronomical detail, or vice versa.

First, I want to look at some historiographical issues. We have some material on Anaximander's cosmology and astronomy, but that can be interpreted in several ways. As ever, I think it is important that we are clear about the criteria we use, as there will be important issues about originality, the role of observation and the sophistication of the model.

There has been an ongoing debate about the proportions of the *cosmos* for Anaximander. The order of the celestial bodies for Anaximander is surprising but clear. We have the earth in the centre, then the stars, then the moon and finally the sun. We have some figures relating the size of the circle of the sun, and of the moon, to the earth. Exactly what those figures relate to and how we reconstruct Anaximander's model of the heavens is far from clear though. Much of the debate has centred around what has become known as 'Kirk's problem' of whether the sun sits in its proposed circle properly. The assumption has been that if we solve the problem of the sun wheel, then we can simply apply this solution to the moon and stars wheels as well. I challenge this assumption and argue that by looking in detail at the nature of the moon and star wheels we can generate some interesting considerations. It has not been recognised that the size of the moon is calculable in Anaximander. The sun is said to be the same size as the earth. If we assume that the sun and the moon have similar angular sizes,

then given that we have the ratio of the circles of the sun and the moon, the moon's size can be calculated.¹ That has some important consequences for how the heavens fit together in Anaximander. Finally in this chapter, I will discuss some supposed difficulties for Anaximander's astronomy and cosmology. There have been concerns about how light is transmitted through the celestial rings, about the angular size of the sun, about how the moon occludes the stars and about how Anaximander might account for seasonal variations for the sun. I will argue that while from a modern perspective there are indeed problems, this does not entail that Anaximander in his context was a poor or negligent observer of the heavens. We should certainly think carefully about whether Anaximander had the same priorities as us in generating a model of the heavens.

Historiography

Couprrie has commented on Anaximander that:

At first sight we recognise them as being rather primitive and obscure, pre-Ptolemaic astronomy. Some authors even think that they are so bizarre and confused that it is better to give up trying to offer a satisfying, coherent explanation.²

I think it is possible to come to a coherent explanation, but there are some important historiographical considerations we need to look at before we start on Anaximander's cosmology. Did every ancient cosmologist believe that the system they put forward was capable of explaining every phenomenon of the heavens? In my view, no. This means we need to be cautious of arguments of the form 'this view would mean that Anaximander cannot explain this phenomenon, therefore he cannot have held it'. My lead example here is the concentric sphere astronomy of Plato, Eudoxus, Calippus and Aristotle.

In Plato's *Timaeus* the earth is central and stationary, the sphere of the fixed stars has one regular circular motion, while the sun, moon and planets each have two, sharing that of the stars and moving in a further regular circular motion in a plane whose axis is offset relative to that of the stars. If these are the only motions, then there are some serious difficulties with the model. If the sun and moon are permanently in the same plane, along with the earth, then there will be a lunar eclipse every full moon, and there will be a solar eclipse every new moon.³ These eclipses will always be of the same type.⁴ This model cannot account for the retrograde motions of the planets, nor can it account for the relation of Mercury

and Venus to the sun. This looks all the more problematic as Plato appears to be well aware of both of these phenomena.⁵ If the planets are also in the same plane as the sun and the moon, there will also be far too many occultations of the planets. There will be occultations of each of the planets by the moon roughly once a month.⁶ There will be occultations of the outer planets by the inner planets far too often. There will also be far too frequent occultations of a set of stars which lie in one plane by the moon and planets, while other stars within the zodiac will not undergo occultations at all. Again, Plato would seem to be aware of the phenomena which this model is unable to account for.⁷

There are several ways we can approach the astronomy of the *Timaeus*. My preferred way is to accept that there are only two regular circular motions for sun, moon and planets. The model is a prototype, Plato is aware of some of its deficiencies and Plato, in recognition of this, did offer the challenge as reported by Simplicius:

Plato assigned circular, regular and ordered motions (ἐνγκύκλιον καὶ ὁμαλὲς καὶ τεταγμένον) to the heavens, and offered this problem to the mathematicians, which hypotheses of regular, circular and ordered motion (ὁμαλῶν καὶ ἐνγκυκλίων καὶ τεταγμένων) are capable of saving the phenomena of the planets, and first Eudoxus of Knidos produced the hypothesis of the so-called unrolling spheres.⁸

Thus the account of the *Timaeus* is strong on cosmological principle but weaker on astronomical detail. The alternative is that we can drop the idea of two entirely regular circular motions for sun, moon and planets and have a model which is weaker on cosmological principle but stronger on astronomy. How far we go with doing that is then an interesting question, as to account for all of the phenomena that Plato appears to be aware of would mean wrecking the notion of regular circular motion entirely. If we account for planetary retrograde motion, we lose the regularity of circular motion. If we account for deviation in latitude for sun, moon and planets, then circularity is lost. If we allow deviation in distance from the earth, again circularity is lost. Simplicius, quoting Sosigenes, tells us that:

These [unrolling spheres] of Eudoxus' school do not save the phenomena, not only those that were found later, but also those known before and recognised by them.⁹

He then gives us evidence concerning variations in planetary distance, some of which we saw above, and he refers to annular eclipses. He also tells us that it is evident to the naked eye that the moon does not always lie at the same distance from us, as it does not have the same size even when the conditions under which it is seen are similar. That is interesting, as it seems to show that Eudoxus and his

school were aware of phenomena which their model was not able to account for. Indeed, it is very hard to see how concentric sphere astronomy could ever account for these phenomena if they are to be explained by varying distances of the objects from the earth.

One further consideration here is that the ancients sometimes made errors. Aristotle's account of eclipses is a case in point.¹⁰ He understood eclipses perfectly well, but his theory of how we see the celestial bodies,¹¹ that their motion sets on fire small sections of the fiery part of the terrestrial realm, has disastrous consequences.¹² Effectively, each body shines by its own light, which ruins the theories of lunar and solar eclipses. The moon would not stop shining when the earth is between the moon and the sun.¹³ Couprie has also done interesting work in pointing out deficiencies in diagrams drawn by moderns to represent Anaximander's model of the heavens.

A map of the cosmos?

Couprie is admirably clear on historiography and intentions:

It is possible to draw a model which is both in agreement with the doxographical tradition on Anaximander's astronomy, without making special assumptions, and explains the motions of the heavens as seen from a flat earth.¹⁴

Whether Couprie fully succeeds in this ambitious programme we will see later on. It would be remarkable if Anaximander did manage a full account of the motions of the heavens many years before the models of Plato, Aristotle and Eudoxus, which did not.

There is one further historiographical possibility that we need to consider here. Couprie has commented that:

The most natural reading of Anaximander's numbers is to treat them as instructions for drawing a map of the universe.¹⁵

I take that as a very interesting suggestion, especially in the context of Anaximander having drawn a map of the world. There is evidence to show that Anaximander was interested in distances. Simplicius, *Commentary on Aristotle's On the Heavens*, 471, 1–9 tells us that:

So let these things, he says, be in accordance with astronomy. There demonstrations have been given concerning the order of the planets, their sizes and their distances, Anaximander having been the first to give an account of

their sizes and distances and according to Eudemus' history the Pythagoreans were first to give the order.

Diogenes Laertius, *Lives of the Philosophers*, 2, 1–2 also tells us that Anaximander constructed a sphere:

He was first to draw a map of the earth and the sea and he also constructed a sphere.

Certainly that should not be taken in the later sense of an armillary sphere.¹⁶ Some commentators deny that Anaximander generated any three-dimensional image of his cosmos;¹⁷ I take the view that it is possible that he did so, but the model would have been quite crude. Whether Anaximander drew a two-dimensional map of his *cosmos* does have some interesting consequences. We have some proportions for the *cosmos* from Anaximander relating to the sizes of the celestial wheels, but we are unsure if these are radii, diameters or circumferences. I agree with Couprie that if the numbers are instructions for drawing a map, then they have to be radii, as that is the key dimension for setting a pair of compasses (or similar instrument) to draw a circle.¹⁸ However, it is a conjecture that Anaximander's numbers are instructions for drawing a map. A final point, which Couprie has rightly emphasised. It is often important that we remember that for Anaximander the earth is flat, as that can sometimes make a significant difference to how the heavens are perceived. I would add that it is also important to remember that the sun, moon and stars are not independent spherical entities, indeed are not spherical entities at all. What we see as sun, moon and stars are the fiery core of the celestial wheels, seen through an aperture.

Anaximander's numbers

The evidence gives us figures of 19 for the moon, 27 and 28 for the sun as ratios for Anaximander's rings.¹⁹ The standard reconstruction of the spacing of the rings for Anaximander comes from Tannery, who in 1887 proposed two series of numbers.²⁰ First we have 9, 18 and 27 and secondly 10, 19 and 28. The first series represents the inner diameter of the rings of the stars, sun and moon respectively. The second series represents the outer diameter of the rings of the stars, sun and moon. These are all multiples of the diameter of the earth. This is an ingenious way of accommodating the evidence we have and giving Anaximander the aesthetically pleasing sequence of 9, 18, 27, which can be seen as an extension of the 3:1 ratio of the earth's width to its depth. One aspect of this theory which

should be noted straight away though is that we only have evidence for 19, 27 and 28. 18 for the moon is a conjecture to fit a supposed lacuna in Hippolytus' text.²¹ We have no information on the size of the ring for the stars, so the figures of 9 and 10 are pure supposition based on the possibility of the 1, 3, 9, 18, 27 sequence, of which we have only 1, 3 and 27, 1 and 3 representing the proportions of the earth.

Tannery sequence:

	Inner	Outer
Sun	27	28
Moon	18	19
Stars	9	10

Numbers in bold are attested values. Other numbers are supplied to fit the sequence.

It is not clear what the numbers represent. They could refer to the circumference, radius or diameter of the earth and the celestial circles. As O'Brien has pointed out:

Whether we think in terms of radius, diameter, or circumference makes no difference in itself. For the figures are relative, not absolute. The *proportions* of the universe will remain the same, provided we compare like with like.²²

Kirk has argued that Tannery's reconstruction involves a miscalculation. If the numbers refer to diameters, then the second series should be two units larger than the first (11, 20, 29) if the earth is the same size as the sun. If the difference in diameter between the inner and outer two circles is one, the gap between them at any point is a half, too small to fit the sun. Couprie has called this 'Kirk's problem'.²³ So perhaps there should be three series of figures, with 9, 18, 27 representing the middle of the ring, 8, 17, 26 the inside and 10, 19, 28 the outside of the ring if we are taking the figures to refer to diameters. It is important to notice a piece of privileging here though. Assuming we have the Tannery sequences of 9, 18, 27 and 10, 19, 28, there are two ways in which 'Kirk's manoeuvre' can be made. One is with 9, 18, 27 as the central figures, so we get 8, 17, 26 as the inside, 9, 18, 27 as central and 10, 19, 28 as outside. Alternatively, we can reconstruct with 10, 19, 28 as central, 9, 18, 27 as inside and 11, 20, 29 as outside. An argument in favour of this reconstruction is that 10, 19, 28 is actually better attested than 9, 18, 27.

Kirk sequence:

	Inner	Centre	Outer
Sun	26	27	28
Moon	17	18	19
Stars	8	9	10

Kirk sequence, alternative possibility:

	Inner	Centre	Outer
Sun	27	28	29
Moon	18	19	20
Stars	9	10	11

I do not want to argue for this alternative sequence, merely to point out that it is possible. The advantage of the Kirk view is that, on the assumptions being used here,²⁴ and the most natural reading of the evidence, the problem with the sun wheel is solved. The disadvantage is that not only do we not have any of the values for the third series required here, we also have no evidence for the existence of a third series of numbers. A different solution here is to take the numbers to refer to radii and not diameters. While the proportions between the wheels remain the same, if the radii for the sun are 27 and 28, then the diameters are 54 and 56. The sun retains its size as the same as the earth, but now fits into its wheel. This has some consequences for the apparent size of the sun, which we will look at later.

There are many ways to reconstruct Anaximander's cosmology on the numbers that we have and it is important to be aware of the choices we have at each stage and the principles we use to make those choices.²⁵ Clearly, the sequence of 1, 3, 9, 18, 27 has its attractions. Kahn refers to this as a 'neat sequence'²⁶ and goes on to say:

Unfortunately there is little documentary basis for this attractive result.²⁷

Later, Kahn says:

The one suggestion which is really difficult to resist is Tannery's reconstruction of the simple arithmetic series 9–18–27, for the circles of the stars, moon and sun respectively. The inherent plausibility of this conjecture is very great, when we take into account the ratio of 3:1 for the earth's dimensions as well as

Anaximander's general use of mathematical proportion. But the documentary evidence for this particular series is weak, and it must remain only a good guess.²⁸

One reason for printing the attested figures in bold in these tables is to keep in mind what little we know in relation to how much we supply in these reconstructions. I agree with Kahn that this is a 'neat sequence' and an attractive result and for anyone trying to construct a positive picture of Anaximander, is difficult to resist. We should be suspicious, or at least conscious, of that. Some scholars have simply ignored numbers which do not fit into their preferred sequence; others have argued that 28 must be a textual corruption, though there is no more reason to suppose that on textual grounds than there is to argue that 27 is a corruption.²⁹

The sun wheel

The issue of the size of the sun wheel (whether we measure that in terms of radius, diameter or circumference) should also involve questions of the nature of the sun wheel and its proportions in all dimensions. So we need also to consider the cross-section of the sun wheel, its shape and dimensions. There is an important assumption here which Kirk makes:

Assuming, what seems reasonable, that the fellow³⁰ is one earth diameter thick.³¹

How sound is this assumption though? The relevant information that we have on the sun is that the sun is equal to the earth (τὸν μὲν ἥλιον ἴσον τῇ γῇ εἶναι, Pseudo-Plutarch, II, 21, 1 Stobaeus, I, 25, 1c, τὸν μὲν ἥλιον ἴσον εἶναι τῇ γῇ, Stobaeus, I, 25, 1c).³² The most natural reading of the evidence, and the generally accepted one, is that the circle of the sun is the same size as the circle of the earth, viewing the cylinder of the earth end on. However, it would be most improper to assume that the diameter of the circle of the sun is also the diameter of the sphere of the sun, because there is no spherical sun in Anaximander. We are viewing a ring of fire through a circular aperture in the surrounding compressed air. In a great deal of the debate concerning 'Kirk's problem', there seems to be an assumption that the height of the sun wheel is the same as the height of the sun and that the depth of the sun wheel is also the same as the height of the sun. To be clear here, I will discuss (a) the height and the width of the sun, which are the same as the diameter of the sun, and are the same as the size of the aperture in the sun wheel; (b) the height of the sun wheel (which may or may not be the

same as the height of the sun, depending on the model); and (c) the depth of the sun wheel as the distance from the nearest point of the sun wheel to earth to the furthest point (which again may or may not be the same as the height of the sun, depending on the model).

There is a major problem with the assumption that the size of the aperture is equal to the height and depth of the sun wheel, which so far has only been recognised by Naddaf.³³ If the size of the sun, effectively the core of the sun wheel, exhausts the dimensions of the sun wheel, then there is no room for the compressed air surround. Any reconstruction of the sun wheel which fails to allow space for the compressed air surround surely fails on that point. Without the air surround we would see a band of light all the time, not just the circular sun during the day. So the thickness of the surrounding air must be factored in. The problem for any model where the height of the sun is equal to the depth of the sun is that when the compressed air is factored in, the sun ring will be larger than the height and depth of the sun. As the depth is greater than the size of the sun, then the model will run into difficulties with Kirk's problem.³⁴

Do we have any indication of the depth of the sun (i.e. the depth of the fiery core of the sun wheel)? If we press the idea that the sun is the same size as the earth, then the depth of the sun is one-third of its width.³⁵ On this assumption, both the Tannery and the Kirk sequences can be saved. We have no indication of the thickness of the compressed air surround. That generates a further unknown in any calculation of the proportions of the heavens for Anaximander. Two ways of juggling the figures would be $1/3$ for the depth of the sun, with $2 \times 1/6$ for the depth of the compressed air giving a depth half the width, so saving the Tannery sequence,³⁶ or $1/3$ for the depth of the sun, with $2 \times 1/3$ for the depth of the compressed air giving a depth equal to the width, so saving the Kirk sequence. O'Brien has a variation on the principle that the sun has the same proportions as the earth. O'Brien believes that the ratio of depth of the earth is three times not one-third.³⁷

A further issue here is that we do not know the shape of the cross-section of the celestial wheels for Anaximander. We might suggest that rings are circular in cross-section, as with a bicycle inner tube. In favour of this idea are symmetry considerations. Against this idea is the comparison of the rings to cart wheels.³⁸ Cart wheels are quadrilateral in cross-section. What sort of quadrilateral is another issue. They might be square (depth equalling width of the wheel rim), or they might be under-square or over-square (depth less than width, depth greater than width).³⁹ Depending on how hard one wants to push the comparison, one could try a history of technology answer here, by investigating the cross-sections

of Greek cart wheels. How much that would help though is open to doubt, as that may push the comparison with cart wheels too hard. Although that is an important objection to the wheels being circular in cross-section, it is not necessarily a decisive one. What is in the heavens are like cart wheels, but are not. So there will be similarities but at some point we have to decide that the similarities end (e.g. while a cart wheel must have something which connects the felloe to the hub, the general assumption is that there is no such thing for Anaximander's celestial wheels).⁴⁰ So, too, cart wheels were made of wood but no one is suggesting that for Anaximander's celestial wheels. We may then be free to suppose circular cross-section. Of course, one might object to the assumption that the sun is the same size as the earth in depth as well as circumference on similar grounds. The diameter of the sun and earth may well be the same, but if the sun is what we see of a fiery core of a celestial wheel, to talk of the depth of the sun being equal to the depth of the earth pushes the similarity too far. However, that is the only indication we have of the depth of the fiery core for the sun.

Naddaf's view is that the sun wheel's fiery core, viewed in cross-section, is three times as high as it is wide.⁴¹ It is surrounded by a layer of air which has uniform depth.⁴² A different possibility here is to agree with Naddaf that the sun wheel's fiery core, viewed in cross-section, is three times as high as it is wide, but I propose that the surrounding air forms a circular cross-section. That may make for better symmetry, but we have very little in the way of evidence to determine the depth of the compressed air. One can here look to Pseudo-Plutarch, *Miscellanies*, 2 (= Eusebius, *Preparatio Evangelica*, I, 8, 2, DK12A10), which says:

A sphere of flame was formed around the air around the earth like the bark around a tree. When this was broken off and enclosed in certain circles, the sun, moon and stars were formed.

One might reasonably suppose that the compressed air is around the fiery core of the celestial wheels in the same manner, Anaximander's favourite bark analogy. That can cut both ways. In favour of the circular view, bark is usually circular, or at least a reasonable approximation of it. In favour of Naddaf's view, bark is usually uniformly thick, or at least a reasonable approximation of it. It may be better simply to accept that we do not know, and on the current evidence have no way of knowing, the disposition of the compressed air surrounding the fiery core for either the sun wheel or any other wheel in Anaximander.

Couprie has a somewhat different view, though again based on the notion that the sun is one-third deep as it is wide. Couprie suggests that the 'sun' in the passages where the sun is compared to the earth, refers not to the sun as we see

it but to the cross-section of the sun wheel.⁴³ For Couprie the sun wheel is then as wide as the earth but only 1/3 of that width in height. So this is like Naddaf's model, turned through 90 degrees. I think this is a much less natural reading of 'the sun is equal to the earth', and usually where we get this comparison, as with Anaxagoras saying that the sun is the size of the Peloponnesus, the sun as we see it is meant.⁴⁴ In its favour is some evidence that the fellows of cart wheels had similar proportions around Anaximander's time.⁴⁵ However, if the earth/sun comparison is a reference to the cross-section of the sun wheel, then there is nothing which determines the size of the sun aperture. We can then assume whatever size of aperture gives the correct angular size for the sun at whatever distance we suppose the sun wheel to be. The only restriction here is that with the height of the sun wheel set at one-third of the diameter of the earth, the aperture is smaller than that. There is an important calculation to be made with Couprie's model for the sun. At the distance for the sun on Couprie's model, the angular size of the sun, if it was presented will be just over two degrees. However, we are presented with the edge of the sun, only one-third as high as the face of the sun. Can the size of the sun as we see it fit into this? The actual sun is half a degree, Couprie's fiery core will be one-third of just over two degrees. So the aperture for the sun will just fit. See the calculation for the moon in a note in the next section though, as the figures are a little more critical, the moon being slightly larger in relation.

The moon wheel

Perhaps, then, Kirk's problem, that of the depth of the sun wheel, can be solved, if we take the fiery core of the sun wheel to be one-third of the diameter of the sun. Unfortunately, as we have no indication of the depth of the compressed air surrounding the fiery core, we can have either the Tannery sequence or the Kirk sequence, or indeed neither of those. There is a further difficulty which none of the literature seems to have considered though, perhaps on the assumption that the solution to Kirk's problem is generally applicable to all the celestial wheels. The problem is, what are the depths of the moon wheel and the star wheel? Depending on whether we use Tannery's series (9, 18, 27 and 10, 19, 28) or Kirk's series (8, 17, 26 and 9, 18, 27 and 10, 19, 28), the wheels for the moon and the stars will be one unit wide to preserve the sequence. What grounds do we have for believing that?

There is one fact we need to take into consideration here. This is that the size of the moon is calculable for Anaximander. We know that the sun is the same

size as the earth and the reasonable assumption is that the face of the sun and the surface of the earth are the same size. The sun and the moon have roughly the same angular size, whatever we take that to be.⁴⁶ We can then calculate how much smaller the moon must be to appear to be the same angular size as the sun on its smaller orbit. The calculation is very simple if we take the wheel of the sun to be 27 and the wheel of the moon to be 18, however measured. The moon is two-thirds of the size of the sun.⁴⁷ All I need here is that the moon is significantly smaller than the sun. Now let us try some principles here. If the depth of the moon wheel is the same as the diameter of the moon, however calculated, then the depth of the moon wheel is significantly less than that of the sun. This wrecks both Tannery's and Kirk's sequences, indeed any sequence which assumes that the depth of the moon wheel is the same as that of the sun.

What shape is the fiery core of the moon wheel? We have no information on this, so our only assumption is that the moon has the same proportions as the sun and the earth. So one can have the Naddaf model of the core being three times as high as it is wide in cross-section, or the Couprie model of three times as wide as it is high. As the moon wheel's fiery core is going to be smaller than that of the sun, we can now pack the rest of the moon wheel with compressed air to get the desired size to fit with either the Tannery or the Kirk sequence. Again, though, the depth of the compressed air covering is entirely arbitrary. We can make this fit the Tannery or Kirk sequences or choose not to.

An alternative here is to have a similar fiery core for each of the celestial wheels, based on that of the sun. We might then give up the notion that in each case we see the full height of the fiery core through an aperture. So while the sun has an aperture revealing the full height of the fiery core, the aperture for the moon is smaller and there are many small apertures in the star wheel giving us the star field. A more radical alternative would be to do this for the sun as well, such that the sun aperture does not reveal the full height of the fiery core, as with Couprie's model.⁴⁸ The questions here would be why we should assume all of the celestial wheels have the same structure other than the apertures and why, if that is the case, we should take the sun wheel as paradigmatic?

The star wheel

There is a final consideration, which is the depth of the star wheel. Here we can be less precise, as we do not have a ratio between the angular sizes of the stars and the moon or sun.

All we can say is that the stars are much smaller in angular size than the moon and are nearer. If the wheel of the stars is as deep as the height of a star aperture, it is going to be very thin indeed and again the Tannery and Kirk sequences will be wrecked. We might assume that the star wheel is the same height as the sun wheel, but with smaller apertures distributed on it, giving us a band of the star field. If we assume too that the star wheel has the same depth as the sun wheel, then the Tannery and Kirk sequences will be saved.

Can the recognition that the fiery centre of the wheels must be surrounded by compressed air, which ought to be taken as part of the size of the wheel, save the Tannery and Kirk sequences here? In a sense, yes, but there are two significant worries with such an approach. As long as the celestial bodies are not as deep as the band in the proposed sequence, we can fill up the remaining space with compressed air. However, that would be entirely *ad hoc*. The second concern here is that the fiery core of the sun would require the least covering of compressed air, the stars the most with the moon somewhere in the middle. In the next section, we will look at the problem of how it is we can see the outer celestial bodies through the wheels of the inner celestial bodies. That problem is going to be considerably exacerbated if we have far more compressed air around the stars than we have around the sun.

One problem with Anaximander's model is the account of the stars. Are the stars on a wheel similar to that of the sun and the moon? If so, only a narrow band of stars could be accounted for. On the usual calculations of just over two degrees or just over four degrees for the angular size of the sun, this would also give us the height of the star wheel. It would need very many star wheels of this size to give us anything like the full star field. So perhaps we have multiple wheels for the stars. In itself, that may not be so much of a problem. If the gaps between the wheels are chosen carefully (where there are few or no stars visible to the naked eye), the wheels may still give us a good representation of the star field. However, there is a question of how successive star wheels will be spaced on the basis of the model we adopt for the celestial wheels. On models where the compressed air surround is not discussed, one might have the impression that the wheels can be quite close together. However, if the compressed air surround has a significant thickness, there will be a gap of twice that thickness between bands of stars even if the wheels have no space between them. On a model where the depth of the compressed air is a third of the diameter of the sun (e.g. the wheel is $\frac{1}{3}$ air, $\frac{1}{3}$ fiery core, $\frac{1}{3}$ air in depth) so the height of the whole wheel is the diameter of the sun plus $\frac{1}{3}$ air + $\frac{1}{3}$ air, then $\frac{2}{5}$ of the star field cannot be reproduced.

There is also an interesting problem with the star wheels the closer we go to the pole star. Imagine the axis of rotation for the stars running through the centre of the earth. The star wheel model works in its simplest manner for the wheel centred on the centre of the earth and presumably at 90 degrees to the axis of star rotation. Now go celestial north (or south) to the next star wheel. Is its diameter, as measured from the axis of star rotation, the same as the first star wheel? Or, put another way, do the successive star wheels, going celestial north, from a partial tube or a partial sphere, close on the pole. In the first case, the circumference of the star wheels will remain at nine times that of the earth, but the distance will increase from nine earth diameter or radii. In the second case, the distance will remain the same, but the circumference of the wheels will become progressively smaller.

One would have to argue either that circumference was the key measure for Anaximander or that the radius and diameter for the star wheels should be measured from the star tube axis, not from the centre of the earth. The latter is highly unlikely, as we have no such qualification in the evidence, which is remarkable given the strongly geocentric nature of the later concentric sphere astronomy,⁴⁹ and it is generally contrary to the Greek geocentric approach. Circumference always seems the least likely possibility for Anaximander's ratios. There is also the problem that while using circumference preserves the ratios of Anaximander's *cosmos*, it also produces the smallest *cosmos* with serious problems concerning the size of the sun and moon.⁵⁰

The tube model also seems implausible. In order to get sufficient elevation to give the appearance of closure, or near closure of the star field at the celestial pole, the star wheels would have to extend well beyond both the moon wheel and the sun wheel. It is possible to imagine that the tube of the stars passes through the wheels of the sun and the moon without touching them. However, it should also be clear that it is possible to imagine angles for the wheels of the sun and moon whereby those wheels would have to pass through the star tube, especially if there is change in their angle of inclination. This would raise the serious problem of how the star wheels would interact with the moon and sun wheels.

An alternative to many star wheels making a partial tube or a partial sphere is to dispense with the idea of many star wheels and argue for a single continuous tube or a single continuous sphere. The problem here, though, is the wheel description, as neither an extremely elongated tube nor a sphere could in any way be conceived to be a chariot wheel. Couprie is undoubtedly correct to suggest that a continuous sphere for the stars would be the best solution in terms

of astronomy. This would give a complete star field including, if necessary, a pole star which is difficult to produce on the elongated tube model. Whether there is sufficient support in the texts for this suggestion is another matter.

I have two suggestions here. The first would be to drop the idea of star wheels in favour of a star sphere. This means we have to treat some of the doxography as confused or misleading and prioritise the passages which mention spheres. So for the first three passages here, we need to say that either they are giving a general account of the heavens and miss the detail of a sphere rather than a wheel for the fixed stars, that they are confused, or that perhaps *kuklos*, circular, is in some way ambiguous between circular and spherical. While most of the evidence is in favour of star wheel,⁵¹ we do have two passages which suggest spheres. Pseudo-Plutarch, II, 16, 5 (=Aetius, II, 16, 5), cf. Stobaeus, I, 24, 2c, slightly different question, same answer:

Concerning the orbits and motions of the stars.

...

Anaximander, carried by the circles and spheres, on which each moves.

So here we need to read that the sun and moon are carried on wheels while the stars are carried on a sphere. This is one way of reading the evidence, certainly the most generous way to Anaximander if he is to have any sensible account of the fixed stars. Whether that is fully justified by the evidence is another matter. One might alternatively argue that the Pseudo-Plutarch and Stobaeus passages (which are in effect only one passage) are mistaken or confused in mentioning spheres, or that this is a late attempt to 'save' Anaximander by attributing spheres to him. I would also raise the question here of the intent of Anaximander's model of the heavens. If it is not primarily astronomical, but primarily cosmological or even metaphysical in emphasising a sequence of distances and stability, then Anaximander perhaps did not need and did not have a full account of the star field. All he needs is that the stars are equidistant in a manner which will not affect the stability of the earth or the other rings. This may also explain the lack of any distinction between fixed stars and planets.

My second suggestion is that if we are to stay with the idea of a star wheel, let us dispense with the idea of drums or multiple star wheels which have their own theoretical problems and for which there is no textual support. There would be one star wheel, located 9 units away from the earth, with a height similar to the moon and sun wheels. Anaximander's point here, then, would be not to give a full astronomy, but to emphasise the equitable spacing of the elements of the *cosmos* to emphasise the stability of the *cosmos*.

Numbers problem

There is a problem for this whole debate, which is the following passage, printed by Wöhrle from Pseudo-Galen, *On the History of Philosophy*, 67, 1:⁵²

(περί σελήνης.) Ἀναξίμανδρος κύκλον εἶναι ἑκκαίδεκαπλάσιονα τῆς γῆς.

Concerning the moon. Anaximander, its circle is sixteen times that of the earth.

If we accept that Anaximander did say the moon's circle is sixteen times that of the earth, then the whole basis for the Tannery and Kirk reconstructions falls through. We can reject the evidence of Pseudo-Galen here but need to be careful of our grounds for doing so. It does flatly contradict both Pseudo-Plutarch, II, 25, 1 and Stobaeus, I, 26, 1a on the moon:

Ἀναξίμανδρος κύκλον εἶναι ἑννεακαίδεκαπλάσιονα τῆς γῆς.

Anaximander, a circle nineteen times that of the earth.

The virtual identity of the wording might lead one to suspect a copying or transmission error. One might also take Pseudo-Plutarch and Stobaeus to be better sources than Pseudo-Galen.

It is important though that we recognise that the 1–3–9–18–27 sequence, with the 9/10, 18/19 and 27/28 modification is 'attractive' and 'difficult to resist' as Kahn has put it and do not reject contrary evidence on those grounds alone.⁵³ I have been cautious in the chapter in pointing out the hypothetical basis for this sequence. If we accept this sequence, it has important consequences for symmetry and stability in Anaximander, but there is a need to avoid circularity here and not argue for this sequence on grounds of symmetry or stability in Anaximander.

Light transmission

In the next few sections I want to look at some purported difficulties for Anaximander's astronomy and cosmology. Some are to do with issues of coherence for the system, some with the consequences of the system for observation. That we do not see the compressed air around the fiery core of the celestial bodies is not in itself a problem. As Kahn comments:

It is the essential property of *aer* from Homer onwards to make things invisible, but not necessarily to be seen itself.⁵⁴

However, there is a problem about the transmission of light in Anaximander's cosmology. If we assume that the compressed air surrounding the fiery cores is entirely opaque, how can the light of the sun pass through the moon wheel and the star wheel?⁵⁵ On some depictions of Anaximander's system, which have the star, moon and sun wheels in a single plane, there is supposed to be a relatively simple solution, which is that the further a body is from the earth the brighter it is and there is sufficient compressed air around each fiery core only to prevent light escaping from that particular fiery core. So the light of the fiery core of the sun cannot escape its compressed air surround, save through the aperture, but it can penetrate the compressed air surrounds of the moon and star wheels. A similar consideration is then given to the moon wheel.

However, this solution will not do for more sophisticated accounts of the relations of the celestial wheels in Anaximander. If the axes of the sun and moon wheels are offset, then some of the time the sun will be behind the moon wheel but some of the time it will not. On the above account, we should see the sun brighter when it is not behind the moon wheel than when it is. The issue becomes further complicated when we take the star wheel(s) into account. Do the star wheels, if there are many of them, form a partial tube or a partial sphere? Are they closely packed, such that there is no gap between the compressed air surrounds? What shape is the cross-section of the star wheel? Does light have to go through more compressed air at some points than others? The problem here is to come up with an account of the stars wheels such that they provide an equal impediment to the light of the sun and moon at all points. That, to say the least, looks a rather tricky problem to solve. One solution here is to make the star wheel a fully closed sphere.

Let us assume for the moment that all the celestial wheels have the same proportions as each other. Why is the sun the brightest object in the sky? Is this because its fiery core is more densely packed? That might be plausible as, for many early Greeks, fire is light and moves away from the earth. However, if the fiery core is more densely packed, the compressed air also has to be more densely packed, in due proportion. So, too, the moon and star wheels will need the density of their fiery cores and compressed air surrounds to be in proper proportion.

There is a related problem here for the view that the depth of the fiery core is related to the diameter of a celestial body (being one-third of the diameter, as with the earth). Different sizes for the depth of the fiery core of the celestial wheels will give us different depths of compressed air around those cores if they are to fit the Tannery or Kirk sequences.

However, the depths of compressed air would seem to be inversely related to the depths required by the partial opacity theory. The star wheel should ideally have less compressed air around it, not more, while the sun should have more, not less.⁵⁶ This model does have one significant advantage, as Bodnar has pointed out:

In this reconstruction it is obvious that the farther a celestial body is the brighter it must be in order to be visible. Now the transmitted order of Anaximander is precisely this. Sun, moon and stars follow each other in the sequence of their respective brightness.⁵⁷

This can be opposed by Burkert's view that:

The idea that the stars are closest to the earth, while the sun is furthest away, comes from Iranian teaching on the soul.⁵⁸

This gives us a concrete reason for the order of the celestial bodies in Anaximander, so we do not have to explain this in terms of observation or an influence from another culture. However, the problems with the distribution of the lower bodies which means that in some places light will be hindered and in others it will not tell heavily against this view.

Instead, there is the possibility that within the covered part of the celestial wheel, fire does not emit light but does so only at the aperture. The compressed air is entirely transparent and light passes through it unhindered. It does not then matter what the arrangement of wheels below a celestial body are, we will see the light in the same way. If the first part of this is plausible, then the model works very well. One worry though would be why the air needs to be compressed. It looks as if the air is compressed in order to hinder the emission of light. The downside of this theory is that it does not give us an explanation of the order of the celestial bodies in Anaximander.

Celestial wheels and cosmogony

It should be evident by now that the celestial wheels have a very precise structure, both individually and collectively. They are constituted of fire and compressed air in precise ratios, shapes and structures. Individually, as the good arrangement of separate entities, they could be considered to be *ouranoi* in themselves. If they were, this might well explain some of the confusion in relation to multiple co-existent *ouranoi*. There needs to be a precise arrangement between the wheels such that light is transmitted properly and between the wheels such that cosmic

stability is preserved. An important question to raise, then, is how this state of affairs came about. Here I would disagree with Kahn who says that:

Like all Greeks he believed that fire tends upwards. The surge of flame towards heaven is confirmed for Anaximander by the mention of a sphere which grows outside of – and hence above – the terrestrial *aer*. There would be a general tendency for fire to collect more abundantly near the periphery of the heavens. If the stars provide such little light, it must be because they contain a smaller proportion of fire and belong rather to the region of air. The bulk of flame is concentrated in the outermost circle of the sun, while the moon's position is intermediate.⁵⁹

One minor concern I have here is that this makes Anaximander a little too Aristotelian. Quite possibly Anaximander believed that fire moved upwards, but the layering of fire and air (the region of air) looks too Aristotelian both in the specific idea and in the centrifocal idea of dynamics that seems to underpin it. Actually, there is no region of air for Anaximander, or at least we do not know what he placed in between the earth and the outer layer of the star wheel, where we meet condensed air, or what was between star and moon wheels or between moon and sun wheels.

My major concern, though, is that the recognition that fire rises is nowhere near adequate to explain the structure of the heavens. It may give us a vague notion that fire will be further out than air; the further out we go the denser the fire will be. However, that leaves the structure of the wheels, fire surrounded by air entirely unexplained. Note also that if the fiery core of the sun wheel is surrounded by air, some of this air will be further out than the densest fire. Nor does it do anything to explain why we get a precise sequence of 9–18–27 for the celestial wheels. There is far too much *taxis* in the heavens for Anaximander for any simplistic 'fire rises' account to be able to explain.

Moon occlusion

Dicks has commented that:

Whether there is any truth in Aetius' statement (ii, 13, 7 = DK 12A18) that Anaximander regarded the sun as the highest celestial body (i.e. the furthest from the earth), with the moon next, then the fixed stars, and then the planets (nearest the earth), we cannot tell: if this were his genuine belief, it does not say much for his astronomical competence.⁶⁰

Naddaf has commented that:

If it is true, as astronomers assure me, that it is not difficult to discern the occultations of the stars by the moon, then this also leads to the conclusion that the order proposed by Anaximander cannot be based on observation.⁶¹

A further concern with Anaximander's model is that the stars are closer to the earth than the moon. It is obvious from observing the path of the moon that it is the moon which occludes some of the stars, but clearly this cannot happen on Anaximander's model. The first reply to this is that it is not obvious that the moon occludes the stars. What we see is a large light in the sky render some small lights in the sky invisible. If we accept the idea of a hierarchy of sun, moon and stars for Anaximander, such that the sun can be seen through the ring of the moon and the rings of the stars, then we also ought to accept that the moon can be seen through the rings of the stars. So when the moon is directly behind a star, its light overpowers that of the star which is then invisible to us. There is no need for the moon to pass in front of the stars, it can render them invisible from behind. In the cases of the inferior planets, Mercury and Venus, a similar phenomenon happens in relation to the sun. Mercury and Venus can become invisible to us as their orbit brings them earth side of the sun, as the light of the sun becomes too great for either to be seen. There is no need for a transit of the sun to occur for this too happen. I disagree with Kahn that:

When the moon hides a constellation of fixed stars by passing in front of them, no one would spontaneously imagine that these stars lie between us and the moon.⁶²

Certainly that is so for someone brought up in the modern tradition of astronomy, but is that so for an ancient, especially one who is credited with the first person to give depth to the sky? Couprie has argued that the celestial pole is seen at different heights depending on the observer's latitude on the earth. On a spherical earth, this is easy to explain, but with a flat earth this would necessitate the stars being relatively close.⁶³ That is a problem for the view that the wheels for the stars are a partial tube stretching infinitely far from the earth. The pole star would then be seen at the same height from everywhere on earth. That the moon can overpower a star from behind works well for a relatively full moon, though there would be a problem with a relatively new moon where the star would be occluded by a dark part of the moon.⁶⁴

Angular size of the sun

There is a problem with virtually all of the reconstructions of Anaximander's cosmology we have looked at so far, and that is the angular size of the sun. On

any of the standard interpretations, it is far too large. The sun actually takes up about half a degree of the sky in circular measure, such that it would take 720 suns to generate a full circle around the earth.

These calculations are based on the idea that the sun is the same size as the earth (here assuming that the circular face of the earth equals the circular face of the sun).

If we take it that the sun is 13.5 earth diameters away (here assuming the figures relate to diameters), then the circumference of the sun wheel, as circumference = $2\pi r$, is:

$$2\pi \times 13.5 = 84.78$$

As 84.78 earth diameters constitute the circumference of the sun wheel, each one in angular measure takes up 360/number of earths, so:

$$360/84.78 = 4.25 \text{ degrees}$$

If we take the sun to be 27 radii away, then the circumference comes out twice as large, 169.56, and the angular size of the sun will be around 2.13 degrees. There are minor variations on how to do this calculation. One can take $\pi = 3$, which may have been the case if Anaximander made this calculation. One can use a figure other than 13.5, with some consideration of where you stand on earth or where what we see as the sun sits in the sun wheel. None of this will make any really significant difference and the figure for the angular size of the sun will come out either close to or just over 4 or just over 2 degrees, depending on whether we take the figures as relating to radius or diameter.

One radical try at a solution is to take Hippolytus' text at face value such that the sun wheel is 27 times that of the moon and so is $19 \times 27 = 513$ radii or diameters away from the earth. The circumference is then $2\pi \times 513 = 3221.64$ or $2\pi \times 256.5 = 1610.82$. This then gives us figures of $360/3221.64 = 0.11$ degrees, or $360/1610.82 = 0.22$ degrees. So even this attempt does not give us a reasonable answer, though of course we might want to consider what a reasonable answer would be in the context.

Couprie also has a radical solution, based on the idea we saw earlier that the comparison between the earth and the sun relates to the dimensions of the fiery core of the sun wheel, rather than the aperture of the sun wheel. So Couprie then says:

This aperture can be any size so as to fit the real angular diameter of the sun. In other words, the size (or diameter) of the aperture in the sun-wheel, which is the sun as we see it, may be much smaller, so that 720 suns in a row fit into the circumference of the sun-wheel.⁶⁵

Naddaf's comment on Couprie's view is that:

The major problem I have with this interpretation is that it attempts to make Anaximander's figures correspond at any cost.⁶⁶

Couprie's solution is highly ingenious. In its favour is the fact that it is plausible in terms of the history of technology. There is evidence for the rims of cart/chariot wheels being this sort of shape. With the star wheel, unless we have a wheel for each star, then the aperture for a star is not going to be as high as the fiery core of the star wheel. If the moon wheel has the same proportions as the sun wheel, then the moon aperture cannot take up the full height of the moon's fiery core either. Why, then, need we assume that the sun aperture takes up the full height of the fiery core of the sun wheel? Couprie's solution does give an answer to what otherwise seems an intractable problem. The strength of Couprie's solution is in a sense the main worry though. On this view, the apertures can be any size that is required (as long as they are smaller than the wheels) but there is nothing which determines the size of the apertures. An alternative approach would be to consider other reasons why Anaximander might give a size for the sun. O'Brien has suggested that the sun has to be this size so that it can light the whole of the earth.⁶⁷ However, it is not clear why a smaller sun could not illuminate the whole of the earth. If there were pipes (similar to the nozzle of a bellows) that directed the rays of the sun in a narrow manner, this might gain in plausibility, but there should be no problem from a straightforward aperture. It can be suggested that Anaximander made the sun the size of the earth so as to emphasise that it was not the only significant body in the *cosmos*. The problem with this is that the earth is a different type of body from all the other entities in the heavens and is unique.

Sun size – historiography

Anaximander has come in for some criticism on the implications of his system for the apparent size of the sun. I think a good deal of this is unfair, for a variety of reasons. Think back to when you first found out that the sun is half a degree in angular width and that it takes 720 suns to fill a full circle in the sky. I was surprised by this. My instinct was that surely the sun was bigger than that and that 720 was an awful lot of suns for one circle. If asked, my guess would have been around 2 degrees for the angular size of the sun.⁶⁸ A brief survey of views

of staff and students in my department revealed a wide disparity of views, ranging from small fractions of a degree through to 10 degrees. Only about 5% of respondents gave $\frac{1}{2}$ a degree and 720 suns.⁶⁹ The sun's angular size is then by no means obvious. I am told by astronomers that it is by no means easy to measure the angular width of the sun.

It is sometimes pointed out in relation to Anaximander that Thales had already discovered that it takes 720 suns to fill a full circle. Let us for the moment assume that Thales did give a figure of 720 suns. We do not know how he came to this conclusion: the word 'discovery' here may be misleading. Was it a convincing calculation based on sound and accurate measurement? Or was it a guess based on instinct? If the latter, Anaximander was perfectly at liberty to disagree with Thales.⁷⁰ What is the force of such an argument supposed to be? If Anaximander 'discovered' that the earth is free floating, not in need of support and that the celestial bodies pass under the earth, then is it no longer possible for someone to think otherwise? Anaximenes and Xenophanes are both clear cases of later thinkers who disagree. All the reference to Thales shows is that the angular size of the sun was an issue around the time of Anaximander.

I have been careful to phrase the issue for Anaximander as 'the implications of his system for the apparent size of the sun.' We do not have figures from Anaximander for the angular size of the sun or how many suns it would take to generate a full circle. Did he realise that the proportions he gave for the *cosmos*, along with the idea that the sun was the same size as the earth, gave a sun that was too large? That may depend on a question I raised earlier. Is the emphasis in Anaximander's work on cosmological principle or on astronomical detail? If the former, then it is quite possible that he did not recognise the implications for the size of the sun.

Finally, there is a question which has perplexed historians of astronomy. It would seem that Aristarchus took 2 degrees as the angular size of the sun very much later in antiquity. In Aristarchus, *On the Sizes and Distances of the Sun and the Moon*, hypothesis six, the moon is said to subtend one-fifteenth part of a sign of the zodiac (so one-fifteenth of 30 degrees, which is 2 degrees),⁷¹ while hypothesis two is that the sun and the moon have the same angular size. Against this, in *The Sand Reckoner*, Archimedes attributed the discovery that the sun subtends around $1/720^{\text{th}}$ 'of the zodiac circle' to Aristarchus. This might cause us to be concerned about the attribution of this discovery to Thales. It is possible, as Tannery has argued,⁷² that Aristarchus knew that the actual value he gave for the size of the sun and moon did not affect his calculation. It is also possible, as Heath has argued, that *On the Sizes and Distances of the Sun and the Moon* is an

early work and Aristarchus discovered a much better figure later in his career.⁷³ It is interesting that Macrobius mentions a figure of $1\frac{1}{2}$ degrees for the sun, based on measurements taken as the sun rises over the horizon. Macrobius attributes this to the Egyptians, though there are reasons to be suspicious of that. One can take two views here. If this was an early Egyptian observation, Anaximander might have known of it, or we might say that it was quite possible for people to try to measure the size of the sun but get it wrong, whether we date this attempt early with the Egyptians or later with the Alexandrians.

It is by no means clear, then, that a figure of around 2 degrees for the sun, in context, was clearly incorrect. It is not clear that Thales 'discovered' the 'correct' figure before Anaximander, or what the import of that is if it is true. Instinctive estimates of the angular size of the sun vary a good deal and there is evidence of attempts to measure the size of the sun which give a similar figure to the one we project on Anaximander. If Anaximander was more of a cosmologist than an astronomer, it is not clear that he would have made the calculation required for the angular size of the sun which seems so evident to modern historians of astronomy.

Solstices and equinoxes

There is an issue with Anaximander's astronomy which concerns how sophisticated the paths of the sun and moon are. If they have simple circular paths, then their path across the sky will be the same every day/night and they will rise and set at the same points on the horizon. This is contrary to what we see, and it is clear from the evidence that Anaximander was aware of solstices. Eusebius, *Preparatio Evangelica*, X, 14, 11 tells us that:

Anaximander was a student of Thales, being the son of Praxiades and of the people of Miletus. He was first to construct a gnomon so as to distinguish the turnings of the sun, time, seasons and equinoxes. Anaximander was well-known to Anaximenes, son of Eurystatus of Miletus.

There can be little doubt that Anaximander was aware of solstices and equinoxes. The varying height of the sun throughout the year (so too the moon) is evident enough to the naked eye and can be measured with a gnomon. Given the description of the celestial wheels, there can also be little doubt that the stars, moon and sun have circular paths. Whether there is regular circular motion is a different issue. Geminus tells us that:

The Pythagoreans, who were the first to apply themselves to investigations of this kind, assumed the movements of the Sun, the Moon and the five planets to be circular and uniform. They would not admit, with reference to things divine and eternal, any disorder such as would make them move at one time more swiftly, at one time more slowly, and at another time stand still.⁷⁴

One can read this as locating the origins of the idea of regular circular motion with the Pythagoreans, although we should have doubts about the reliability of evidence attributing such ideas to them. We simply do not know if Anaximander supposed the revolutions of the celestial wheels to be uniform or not, though if he did, it is not credited to him in any of the histories of astronomy or the work of Aristotle or Theophrastus. Certainly we should not attribute to Anaximander the combinations of regular circular motions for the sun and moon that we find later in Plato and Eudoxus, such that the sun and moon also have the motion of the stars.

If it is decided to give the sun and moon motion beyond a circular motion in order that Anaximander can have an account of solstices and equinoxes, variable heights of sun and moon, etc., then there are various ways in which this can be done. One older way is to think of the sun wheel as a tube, as we did earlier with the star wheel. The sun wheel does not extend too far, as it only needs to cover the sun's annual motions. The aperture for the sun then moves around in this tube as required. One problem with this model is one we have seen in other contexts, which is that a tube is simply not a reasonable interpretation of a chariot wheel. One can do the same thing with the moon, having a moon tube with the aperture moving appropriately. Some reconstructions have given specific sizes for the sun and moon tubes. These are usually given in angular terms. The sun can move 'up' the tube 23.5 degrees, the angle of the ecliptic, as measured from the earth and can move a similar angle down giving a tube size of 47 degrees. The moon tube is 5 degrees larger, as the moon has a 5 degree greater variation in its behaviour than the sun.

These figures give the best reconstruction for Anaximander in terms of accounting for the phenomena. If Anaximander did give extra motion to the sun and moon in this manner, we have no indication of any values for the amount of motion. Historically, it would be more plausible to give ancient Greek values for the sun and moon here rather than modern values but the historiography is to be as generous as possible in reconstructing the model to best account for all of the phenomena it can.

The more modern way of thinking about Anaximander on the sun and moon is to have the wheel of the sun in the normal way with the usual proportions, but

with the wheel capable of moving up and down the celestial axis as required. Again, values such as 47 degrees and 57 degrees can be assigned for the total amounts of motion for the sun and moon respectively.

I would raise two objections to the modern view. One is very similar to that against the tube view of the star wheels. If the sun wheel moves up and down the celestial axis, then it is at varying distances from the centre of the earth and it is no longer clear how Anaximander's ratios apply. One might argue that circumference is the measurement meant, but, as before, this seems the least likely of radius, diameter and circumference and leads to the smallest *cosmos*.⁷⁵ As before, measuring radius or diameter from the celestial axis rather than the earth does not seem appropriate for Greek cosmology. One might argue that the ratios relate to an average earth-to-sun wheel distance or to the critical point when the sun wheel could be said to be at the centre of the celestial axis. I don't think either will do.

I would also note that variable distances for the heavenly bodies was a major issue for concentric sphere astronomy several centuries later. It would be remarkable if Anaximander had a means of varying the distances of the sun and moon which had escaped the notice of all the ancient historians of Greek astronomy and all those who worked so hard and ingeniously to try to make concentric sphere astronomy work.

There is a related issue here, which is that if the distance from the earth to the sun wheel is going to vary, so is the apparent size of the sun. One might cope with that by having a variable aperture size for the sun but it would be a remarkable piece of co-ordination for the sun to have a consistent apparent size despite varying in distance.

The second objection to the modern model of the sun is an equilibrium objection. As we saw earlier, as long as the wheels of the sun, moon and stars are centred on the earth, even if the wheels are inclined relative to the earth the equilibrium argument for the earth's stability still works. However, once we move the sun wheel up or down the celestial axis, then there is reason for the earth to move up or down the celestial axis. Once again a key issue here will be what takes primacy, cosmological principle or astronomical detail?

A further objection to both models is simply this: how do the sun and moon move up and down their tubes in an appropriate manner? If they are carried on wheels, it is easy to see why they would have a circular motion. What, though, generates and governs the motion of the sun and moon up and down their supposed tubes, or governs the motions of the wheels up and down the celestial axis?

Eclipses

The standard view on eclipses in Anaximander is that they occur due to some blockage or closure of the relevant aperture. The usual passage cited is Hippolytus, *Refutation of All Heresies*, I, 6:⁷⁶

ἐπιφρασσομένων τῶν ἐκπνοῶν τὰς ἐκλείψεις γίνεσθαι.

When the breathing holes are blocked eclipses occur.

This is important in that Anaximander provides a fully natural explanation of this phenomenon in contrast to contemporary Greek views. Mourelatos has recently suggested, though, that there is a different and more sophisticated explanation in the doxography.⁷⁷ The fullest form of this is Eusebius, *Preparatio Evangelica*, 15, 51, 1:⁷⁸

περὶ ἐκλείψεως σελήνης. Ἀναξίμανδρος τοῦ στομίου τοῦ περὶ τὸν τροχὸν ἐπιφραττομένου κατὰ τὴν πρὸς ἡμᾶς ἐπιστροφὴν τοῦ πυρώδους μέρους

Concerning the lunar eclipse. Anaximander, the breathing holes on the wheel are blocked, as the fiery part moves laterally in relation to us.

The point of contention here is what ἐπιστροφή means. Usually it is taken to mean turning, but it is also possible, as Mourelatos has argued, that it denotes lateral motion.⁷⁹ Mourelatos' suggestion is that the wheels 'wobble' and, as they change in orientation to us, the breathing hole becomes partially or fully obscured.⁸⁰ There are two possibilities here such that this lateral motion would not affect the equilibrium for the earth. First, if the wheels themselves wobble, they do so with the centre of the wheel still in the centre of the earth. As long as the wheel remains circular and symmetrically related to the earth by having a common centre, equilibrium will be maintained. Alternatively, the wheels may remain in the same position but the breathing hole may change in lateral position, moving up or down on the wheel. This would give more flexibility in explaining full eclipses without having radical motions of the wheels, or constraining eclipses to certain parts of the sky. As Mourelatos notes,⁸¹ this fuller explanation may or may not capture Anaximander's thought but does raise some interesting possibilities. One implication might be that the wheels are circular in cross-section, so the breathing hole could then move without encountering the edge of a quadrilateral cross-section; this would also generate an odd cut-off line for an eclipse. The lateral motion theory would have the drawback that eclipses would only begin and progress at right angles to the direction of travel, which is not, in fact, the case. There is also the issue of moon phases. The Hippolytus passage above continues:⁸²

The moon appears to be waxing or waning in turns due to whether the apertures are opening or closing.

Again, this is important as a natural explanation of an important phenomenon. While the means by which the apertures open and close is never specified, either for eclipses or phases, this theory is very flexible in being able to produce many shapes for the aperture, in any orientation with the phenomenon beginning from any direction. One could not get moon phases from the lateral motion idea, as both the shape of the phases and the orientation of the shapes would be wrong in many cases.

This discussion does raise an issue not often considered. Do the breathing holes move only with the motion of the wheel as a whole, or can they have motion independent of the wheel? The former is usually assumed, but that may impose too mechanical and rigid a conception on Anaximander, appropriate perhaps to a later thinker but anachronistic for him. The alternative would be to see the wheels as more fluid (as they are composed of air and fire) and more biological (as they have breathing holes). Those breathing holes might then be able to move on their wheel. If so, some motion in latitude would be possible, useful in modelling the motions of moon and sun, and Anaximander might be able to account for the motions of the planets relative to the fixed stars if longitudinal motion is possible. I doubt that we have the evidence to settle the mechanical/biological and rigid/fluid issues here, but it is important to be aware that there are alternatives to the mechanical view.

Conclusion

Anaximander's model of the heavens is of considerable interest, but in the reconstruction of many early models of the heavens, many of the parameters are underdetermined. We can, if we choose, reconstruct these in such a way as to get the best model for accounting for the phenomena. Alternatively, we can reconstruct in such a way that cosmological principles are preserved. Often there is a tension between these two modes of reconstruction, which can be found in attempts to reconstruct the models of Plato, Eudoxus and Calippus, to name but three. We cannot assume that every ancient who generated a model of the heavens thought that model capable of accounting for all the phenomena that they were aware of. Apart from the intrinsic implausibility of such a view in the early stages of Greek astronomy and cosmology, there are several clear counter-examples. It should also be noted that the reconstruction of Anaximander's

model is by no means easy, nor is it easy to produce diagrams which faithfully depict all we know of Anaximander, as is evidenced by the diagrams of some modern commentators.

The idea that the wheels of the stars, sun and moon all lie in the same plane as the surfaces of the earth, with the implication that sun and moon could only be seen near the horizon, must be rejected. There is good evidence to show that the wheels of sun and moon are slanted and no cosmological principle is broken. There is good evidence that Anaximander knew of solstices and equinoxes, and the varying heights of the sun and moon as they cross the sky. However, there is no evidence that Anaximander was able to account for these phenomena and attempts to do so breach important cosmological principles.

My sense here is that we should give Anaximander angled wheels for sun and moon but should leave these wheels stationary. This gives Anaximander a strong cosmology but a weaker account of the phenomena. This is not to say that Anaximander was ignorant of the phenomena or had not looked at the heavens, but that in common with others in the early history of Greek astronomy was aware of phenomena that he could not give a full account of in this model. This should be no great surprise. The demand that all who produced a model of the heavens could account for all the phenomena they were aware of is unrealistic for the early history of Greek astronomy.

We must not simply assume that astronomical considerations were paramount for Anaximander. One can calculate the angular size of the sun from the evidence but it is not clear that he did so. So, too, one can do calculations for the moon with implications for the wheels, but Anaximander may not have realised this. We can attempt something which will give a better star field for Anaximander, but we do not know that he would have been interested in such a project.

Anaximander's Numbers

As we have seen, there are a set of proportions for the *cosmos* which have been attributed to Anaximander. The depth of the earth is one-third of its width. 9, 18 and 27 are the ratios for the inner rim of the wheels of the stars, moon and sun, while 10, 19 and 28 give us the outer rims. There is a question of the provenance and meaning of these figures. What led Anaximander to postulate these particular figures for the proportions of the cosmos? The main theories concerning Anaximander's numbers can be grouped under four headings:¹

1. That these numbers are derived from previous mythologies and have some mystical significance.
2. That these numbers are in some way derived from observational astronomy, either that of Anaximander or some of his predecessors.
3. That Anaximander was influenced by the new architectural techniques of his time and these numbers are derived from proportions used in architecture.²
4. That Anaximander's inspiration was political, that there is an interesting relation between how political space and physical space is thought of and that Anaximander's numbers express an ideal relation between the social classes of the *polis*. In this he might be considered to be an idealist, as was Plato slightly later.³

I want to offer two new perspectives here. First, we can treat Anaximander's number sequence in a parallel manner to his meteorology. There I argued that the key fragment has a direct allusion to Hesiod but Anaximander gave explanations in entirely natural terms in contrast to Hesiod. With the number sequence we have allusions to the usual suspects (Homer, Hesiod, Theognis) but the numbers are stripped of any mystical significance and transformed to be part of a radically new concept of cosmology. Anaximander also gives concrete geometrical proportions for the *cosmos* rather than poetical images. The second perspective involves teleology. I have argued that the steering principle in

Anaximander is often underplayed by commentators and can have an important role in his cosmogony. What I want to suggest here is that the chosen numbers bestow important characteristics on the *cosmos* (equality, stability) which can be seen as a good end state. In the sense that the steering principle aims for this end state, Anaximander's cosmogony and cosmology can be seen as teleological.

The view I will argue for, then, radically reformulates position (1) above and makes Anaximander a critic and transformer, not a follower of his predecessors. While I would place more emphasis on Anaximander as a cosmologist than as an astronomer, I am happy that he did observe the heavens. We have seen that there is also a debate about whether the ratios are of radii, diameters or circumferences. If Anaximander does allude to Hesiod, then the question can be settled definitively. It is radii that are the key measure. I also look at some supposed oriental influences on Anaximander's cosmogony and cosmology and argue, *contra* West, that we have no need to go to Oriental sources for Anaximander's cosmology and cosmogony.

Allusion and re-formulation

Let me begin with a quote about Anaximander's numbers from Heath:

These figures suggest that they were not arrived at by any calculation based on geometrical considerations, but that we have merely an illustration of the ancient cult of the sacred numbers of 3 and 9. 3 is the sacred number in Homer, 9 in Theognis, 9 being the second power of 3. The cult of 3 and its multiples 9 and 27 is found among the Aryans, then among the Finns and Tartars, and next among the Etruscans (the Semites connected similar ideas with 6 and 7). Therefore Anaximander's figures really say little more than what the Indians tell us, namely that three Vishnu-steps reach from earth to heaven.⁴

In response to this there are two critical points. First, in Anaximander there is no eschatology. There is no mention of what happens to the soul after death. Of critical importance is the fact that the cosmology does not have a place or places for the soul to go after death. There is no heaven and no underworld in Anaximander for souls to journey to, whatever names various cultures have given to those ideas. So in this sense, there is no heaven in Anaximander. There is, perhaps, a different, non-eschatological, sense of heaven though, as the sky, conceived of as an entity in itself which encloses the earth. That is fine, but Anaximander did not believe in a sky either and that is one of the most important aspects of his cosmology. As Couprie has put it, Anaximander discovered space.

There is no unitary hemispherical entity for Anaximander, which can be called the sky, as there was in previous mythological accounts. We may, in one sense, 'see' the sky but that is not actually what is there. There are wheels for the stars, moon and sun which occupy part of what we see above us. Outside the wheel of the sun there is the *apeiron*. The comparison with Vishnu-steps to heaven makes no sense because for Anaximander there is no heaven in the required sense, either as a repository for the souls of the dead or as a specific entity which encloses the earth, is relatively close to it and limits the depth of space.

The possible allusion to Hesiod in relation to Anaximander's numbers is very interesting here. Hesiod, *Theogony*, 720–5 runs:

As far below the earth as heaven is from the earth
 For this is as far as misty Tartarus is from the earth.
 Nine nights and days a bronze anvil
 Falling from heaven, will reach the earth on the tenth.
 Nine nights and days this bronze anvil,
 Falling from the earth, will reach Tartarus on the tenth.

Important here is the 9 + 1 formula, as 9 + 1 figures in the standard sequence for Anaximander, representing the distance from the earth to the stars. If there is an allusion to Hesiod in Anaximander's numbers, then it is clear from this passage that we should treat Anaximander's numbers as radii.⁵ Here the distance of 9 + 1 from the earth to the heavens and 9 + 1 from the earth to Tartarus is quite specific. 9 + 1 also ought to be the distance of the star wheel from the earth, not the diameter of the star wheel. There are some further examples of the 9 + 1 formula in Greek mythology. In Homer, the siege of Troy takes 9 years before the conquest in the tenth year; Odysseus roams the seas for 9 years before returning home in the tenth. In Hesiod's *Theogony*, a god who drinks from the river Styx is exiled for 9 years but can return in the tenth.⁶ In the *Theogony*, Zeus has 9 daughters, this passage coming just before the description of the making of the world.

If anyone is wondering how far an anvil day might represent, here is a quick calculation, assuming that 200 mph is the maximum speed an anvil could attain in free fall:⁷

$200 \text{ mph} \times 24 \text{ hrs} = 4,800 \text{ miles} = 1 \text{ anvil day}.$ ⁸

$200 \text{ mph} \times 24 \text{ hrs} \times 10 \text{ days} = 48,000 \text{ miles from heaven to earth.}$

$200 \text{ mph} \times 24 \text{ hrs} \times 10 \text{ days} \times 2 = 96,000 \text{ miles from heaven to Tartarus.}$

Having said that, I doubt that Hesiod has any idea in quantitative terms of how quickly an anvil would drop, or indeed any interest in quantifying the anvil day.⁹ I take this as a poetic expression of something exceedingly heavy dropping exceedingly fast, possibly based on the pre-Galileo notion that the heavier an object is, the faster it will fall, perhaps allied with a sense that nothing is going to stop an anvil falling.¹⁰

If there is an allusion to Hesiod in Anaximander's numbers, how different are Anaximander's views? Again, there is no heaven, no Tartarus and no eschatology. $9 + 1$ in Anaximander gives the distance from the earth to the star wheel, nothing more. It does so in a geometrical manner, relating a dimension of the earth to a dimension of the *cosmos* in a way that is entirely foreign to the poetical expression of Hesiod. We are given ratios, but there is a perfectly clear means of translating those into absolute distances, as we only need to make a measurement of the relevant dimension of the earth. I would also note that where Hesiod has an anvil dropping, Anaximander has the earth like a section of stone column. Both might be thought of as good examples of something which is going to drop rapidly and definitively unless it is supported and is not likely to be stopped once it has started dropping. However, Anaximander has the earth unsupported and immobile in sharp contrast to Hesiod and his anvil. There is another approach, pioneered by Diels, that:

The whole numerical speculation is in reality only a poetic representation.¹¹

The idea here is that the $9 + 1$ formula does not represent a specific quantity, but in context represents either a great distance or a great passage of time. So all Anaximander says is that it is a great distance to the stars, greater to the moon and even greater to the sun. He simply adopts a poetic expression. I would oppose that view for several reasons. First, Anaximander gives precise geometrical ratios within a precise geometrical construction of the *cosmos*. It is not 'very far' to the stars, it is precisely 9 earth radii. Second, if what I have argued about stability and equilibrium is correct for the celestial wheels, then they are placed at specific and very precise distances from each other. It is not 'very far' to the stars, but precisely the distance required to produce equilibrium and stability. Third, it is far from clear what the cumulative force of successive applications of the $9 + 1$ formula might be. Something like 'very far', 'very far over again' and 'very far followed by very far followed by very far' does not really work if the first $9 + 1$ is meant to be exhaustive of very far and indicate a very long way indeed. If this is what Anaximander meant, then he ought to have said $9 + 1$ followed by $9 + 1$, but he does not. It is not $9 + 1$ and $9 + 1$ to the moon, it is 18 and 19, and it is 27 and 29 to the sun. While it is easy to find the $9 + 1$ formula in Homer and

Hesiod, there are neither successive applications in this manner nor are there any mentions of 18 and 19 or 27 and 28.¹² In Hesiod, effectively we have two statements of the radius of the world, heaven to earth and earth to Tartarus, rather than 9 and 10 to the stars, then 18 and 19 to the moon, 27 and 28 to the sun. Hesiod has two journeys, both marked with a completion (so it is 20 not 19 from heaven to Tartarus) where it is 2×9 and $(2 \times 9) + 1$ to the moon in Anaximander. That it is not $20 (9 + 1) + (9 + 1)$ to the moon wheel may also be significant in that Anaximander does not see getting to the stars as the completion of a journey to the moon but a stage on that journey. So Anaximander's numbers are not a poetic expression of distance, but a precise statement of the proportions of the *cosmos*, or at least a statement that we can make and ought to make precise statements about the dimensions of the *cosmos*.

It is interesting how the relationship between Anaximander and his predecessors is phrased in some commentators. Burkert, for instance,¹³ phrases this in terms of doctrine. So we have similarities between the doctrine of Anaximander and the doctrine of his predecessors (indeed sometimes they are identical). This, though, tends to obscure why a view is held, or any development or change in why a view is held. Arguably, this is a trait of Burkert's work, as he also defines numerology in a way which obscures differentiation between types of numerology or reasons why a numerological view might be held.¹⁴ We at least need to allow for the possibility that ideas were held for different reasons.

Kahn has suggested comparisons with the three steps of Vishnu in Indian thought, where three has a symbolism, not least of beginning, middle and end; it is also important for the unity of the world.¹⁵ Anaximander has three as the common denominator for his proportions. Kahn, though, stresses that it is more appropriate to speak of:

A rational element in Vedic thought than of a mythic element in Milesian cosmology.¹⁶

This is an interesting approach and I have considerable sympathy with views which do not treat the predecessors of the Greeks as entirely irrational. However, I believe this undersells what Anaximander achieves. So here I would tend to side with Naddaf, who comments that:

Even if one were to concede that aspects of Anaximander's cosmological model may not be devoid of external influences, the fact remains that it is Anaximander's fertile imagination which transformed these elements into a highly rational model which appears far more advanced than those of his predecessors, including the Orientals.¹⁷

The emphasis, I think, should be on transformation, as it should be with Anaximander on meteorology.

Column significance

Hahn has commented that:

For Homer and Hesiod, the column separated heaven from earth, for Pindar the column connected heaven and earth, and for the Pythagorean teller of the transmigratory Myth of Er in Plato's Republic, the column ran through the whole cosmos as its central axis. Anaximander fits into this tradition, for he imagined the earth to be a 3×1 column-drum, and the whole universe constructed in column-drum proportions.¹⁸

I would give qualified agreement to the comments about cosmic architecture here. Certainly, Anaximander is within a tradition which uses ideas from architecture in order to generate a picture of the *cosmos* and more strongly sees the heavens as a piece of cosmic architecture. He is different, though, in applying proportions to that model in a way that we do not find in Homer, Theognis or Pindar.¹⁹ Where I would have a more serious disagreement would be with Anaximander's use of the idea of the earth as a column drum in opposition to the use of columns in other models of the heavens. In these other models, the heavens are held up by, connected to or rotate around a column. Anaximander simply has the earth, unsupported, compared to a column stone. That is a very radical departure. The idea of a column plays no part in Anaximander's cosmology. The sky and the heavens are not supported by columns; indeed, there is no sky and there are no heavens. While the earth may be like a column drum, it is not supported by other stones in a column; it needs no support whatsoever. Even if that is in part inspired by architectural considerations relating to the horizontal stability of column stones, it is still a significant departure from both architectural ideas and the idea of the column being physically critical for the fabric of the *cosmos*.

Apeiron and 36

As we have seen, it is possible to hypothesise the number sequence 1, 3, 9, 18, 27 for Anaximander, with 1 and 3 being the proportions of the earth and 9, 18 and 27 being the relations to the stars, sun and moon. West has suggested that 36 is

the next in this sequence, which represents the distance to the outer *ouranos*,²⁰ though it is not quite clear what West means by 'outer *ouranos*' here. If there is an outermost part of the *cosmos* beyond the wheel of the sun, it is not mentioned in Anaximander, for whom there is no such thing as the sky. Perhaps this is meant as the limit of the *cosmos*, where it borders onto the *apeiron*. If the limit of the *apeiron* is meant, it is odd to refer to it as *ouranos*, heaven. West supplies some evidence for 36 being used in pre-Greek cosmologies which we will look at later. The suggestion of 36 is intriguing as a measurement of all that there is, *cosmos* and *apeiron* included for Anaximander. If Anaximander supposed there to be a finite but not limited amount of the *apeiron*, that amount need not be large. If Anaximander thought in terms of a finite amount of space in this manner, it would rule out the possibility of an infinity of co-existent *cosmoi*.

There are two difficulties with the evidence here though. First, there must be a last number in the sequence which gives the proportions of the *cosmos*. It is always possible to add a further number to that sequence to give us a measurement for the *apeiron*, be that 36 if 27 gives us the extent of the *cosmos*, or 45 if 27 gives us the sun wheel and 36 the extent of the *cosmos*. Nothing here compels us to extend the sequence and doing so means taking sides in several disputes about the nature of Anaximander's cosmology. Second, the evidence that West produces for 36 in pre-Greek cosmologies – that Egyptian and Babylonian accounts used 36 stars and based the calendar on them – is very thin. Thus there is some loose association between 'heaven' and 36. It is difficult to see how that will work for Anaximander, as his star wheel is nearest the earth. For Anaximander there is no heaven, so 36 would function as a measure of the circumference of the sky, rather than a radius or diameter, radius being the most likely measure.

A final thought on this topic is that if Anaximander did employ the 9 + 1 scheme, giving the sense of distance followed by some sense of closure, it would be surprising simply to have the number 36 as the final number in the sequence, especially if it is a measure of all there is. One would expect some stronger sense of closure if the limits of the *cosmos* or the *apeiron* are involved.

Astronomy

I agree that there is an important sense in which aspects of model accord with observation. However, it is a very long way from that position to any plausible account of how Anaximander could have derived these numbers from observation. It would seem unlikely on the evidence that we have that

Anaximander himself had the ability to make any observation which would give him any grip on the dimensions of the cosmos. It is also unlikely that he had access to any observations derived from the Babylonians which could help in this context.²¹ One can easily understand the motivation for relating Anaximander's numbers to observation but there is a lack of evidence or any plausible method here. White has suggested that Anaximander took the angular size of the sun to be 2 degrees.²² It would then follow that if the earth and the sun are of the same size, the distance from the earth to the sun is 27 earth radii. The basis for 27 would at least then be observational. Later in antiquity, Aristarchus took the angular size of the sun to be 2 degrees. We have no evidence of what Anaximander thought the angular size of the sun to be and no evidence of any attempt to measure it. As Couprie points out,²³ if Anaximander did try to measure the angular size of the sun, it is strange that he got it badly wrong, though there are other examples of attempts to measure the angular size of the sun going wrong in antiquity. If he guessed or made a rough estimate, it is perhaps a little more plausible.

Architecture

In principle, I am happy with the idea that Anaximander was influenced by architecture. This fits well with one theme of this book, which is that Anaximander drew on folk knowledge in several aspects of his thinking. We have seen this in relation to the Caddis fly and in relation to the prediction of earthquakes. As Hahn states the hypothesis:

Anaximander did not simply copy the architects any more than the architects copied one another. He embraced techniques and methods used by them in order to imagine the design of the cosmos and the stages by which it came to assume its present form.²⁴

The comparison of the earth to a section of a stone column is an evident starting point here. There were indeed sections of stone column that would have the appropriate dimensions.²⁵ An important architectural technique for this theory is that of *anathurôsis*.²⁶ Dressing stone so that it is perfectly flat and level was a time-consuming process. So a technique was developed whereby only the edges of stone faces were dressed, while the rest of the face was slightly hollowed, producing a good fit without as much labour. So for column drums, only an outer band of the drum was dressed, while the central part of the face was made

very slightly concave. In order to facilitate this, the precise centre of the drum face was found and concentric circles were inscribed on the face. Another important technique here was making a hole at the exact centre of a column drum and then fitting an *empolion*, a square or round dowel, which would help guide the fit with the next column drum and also give a degree of lateral stability to the column. It also gives a sense of a central axis for the column which may be important as an influence on the idea of a central axis in Anaximander's cosmology. When a column drum has been prepared in this manner, it looks like a plan view of Anaximander's *cosmos*, a view taken from directly above. That, too, is significant in that plan making was also an important architectural technique.

A further important aspect of architectural technique which Hahn emphasises is modularity.²⁷ The architects would design a module which could be replicated or expanded in due proportion to form a larger structure. Arguably that is the case with Anaximander's cosmology where the $9 + 1$ formula for the star wheel is repeated to generate the proportions for the moon and sun wheels. I would also agree with Hahn that there is a strong sense in which one can say that the design and construction of Greek temples reflected conceptions of organic growth, which fits well with many ideas in Anaximander's cosmology.²⁸ Thus far I am happy to agree with Hahn on Anaximander being influenced by architectural techniques. The inscription of circles on a drum face during *anathurôsis* is certainly very suggestive. I do have concerns about whether one can generate (a) a sufficiently sophisticated model of the heavens for Anaximander from the architectural considerations and (b) the number sequence for the spacing of the wheels in this way. The most natural way of relating a column drum to the model of the heavens is with the surface of the earth parallel to the face of the drum and with the wheels of the stars, moon and sun in the same plane, around the horizon of the earth. The axis of the column is then the axis of the *cosmos*.

However, that is problematic, as the celestial wheels in this model do not lie aslant the earth. One can fix that by imagining the wheels on different axes but then that means the axis of the *cosmos* will not be the axis of the column. Alternatively, one might leave the celestial wheels in place and slant the earth, but once again the axis of the column will not be the axis of the *cosmos*. There is also a problem of the relation of the wheels of moon and sun, as any reasonable model of the heavens for Anaximander would want to put these slanted at slightly different angles. As it stands, the stars, moon and sun are all in the same plane.

One can have a more complex view though, if we think in terms of the *cosmos* as viewed from the side (in elevation) as well as from the top (the plan view).

What we now get is an extension of the circles for stars, moon and sun upwards and downwards from the earth. The problem here is that we still have the issue of matching the axis for the *cosmos* and the axis for the column. If the earth is conceived of as having its faces horizontal, which I think is by far the most natural way for this model, then the axis for the *cosmos* does not match the axis for the column. It is only by offsetting the earth that the axis for the column and the *cosmos* can match. However, in depicting a column drum (the earth) within a column drum itself, one would expect them to share the same orientation. In a plan view of an offset earth, the earth would no longer appear circular, which would seem highly problematic for the whole scheme.

Initially, this may not seem a very strong objection but consider the discussion about the angle of the sun and moon wheels in a previous chapter. In order that the sun and moon have sufficient elevation as they cross the sky, the sun and moon wheels have to have a considerable angle relative to the earth. If we look at Anaximander's cosmos in plan view at right angles to the surface of the earth, the earth will be circular but the wheels of sun and moon will appear oval, indeed quite radically oval. If we look in plan view along the axis of the wheels of sun and moon, then the earth will appear significantly oval rather than circular. Anaximander's cosmological picture could not have been derived directly from looking at the surfaces of column stones.

The second issue here is whether Anaximander's numbers can be derived in any strong or meaningful way from architectural practice. While there were column drums in a 3:1 ratio, there were column drums in many other ratios as well, so it would seem we need some further reason why Anaximander chose 3:1 as the ratio for the earth. Similarly, it may be the case that the ratio of column height to the diameter of the lowest drum of the column in some instances was 9:1 or 10:1. There seem to be other examples though and this was by no means standardised.²⁹

Hahn may well be correct in arguing that Greek temples can be (and indeed were) seen as cosmic architecture and that the columns can be (and indeed were) seen as linking earth to heaven. As he points out,³⁰ for Homer and Hesiod columns separate heaven and earth and for Pindar they link heaven and earth.³¹ The question I would raise is whether that works in a meaningful way for Anaximander as for him, there was no sky. That is more significant than it may appear in this context, because the column takes you from the ground to the roof, from earth to sky and finishes there. There is no depth to the sky where Anaximander specifically wants to say that there is. At this stage, there is no architectural possibility of building another set of columns on the roof of the

first set, let alone a further set on top of all of those, to give a structure for moon and sun. An important consequence here is that the columns cannot be used in a modular manner to construct a multi-level temple symbolizing a multi-depth *cosmos*. The old temple constructions, if they did reflect cosmic architecture, not surprisingly reflected the cosmic structure of the old cosmologies of columns supporting a roof of the heavens. Anaximander in this sense has to make a decisive break with architectural technique in order to imagine his new *cosmos*.³² So I would disagree with Hahn's comment that:

Anaximander imagined the cosmos to be a kind of temple, the cosmic house, along the analogy of the cosmic meaning of the column.³³

This by no means invalidates all of Hahn's thesis. Anaximander was certainly influenced by architectural techniques. However, I do not think we can derive Anaximander's numbers from those techniques. It would have taken a significant leap of the imagination beyond those techniques, an active transformation, for Anaximander to have arrived at his model of the *cosmos*.

With many multi-section columns, nothing holds the sections in place horizontally. There are no struts and there is no secondary masonry work positively locating the column sections in place. However, if there is not perfect equilibrium between the faces of the column sections, the column will fall. One might argue that if this is so, it favours the view of an earth supported by the air which does not move horizontally. However, one might also argue that as soon as Anaximander has to think about the cosmology in three rather than two dimensions (the face of the earth cannot be in the same plane as the wheels of the stars, moon and sun), he might well have generalised the argument so that the earth has no preferred direction of motion. One further thought here is this: architects clearly design their buildings to be as stable as possible for as long as possible. If the cosmic architecture is, then, in some sense, an instantiation of ideal or perfect architecture, with precise ratios, etc., then perhaps we also have the instantiation of a perfect and everlasting stability.

With the architectural hypothesis, there is a strong sense that the *cosmos* not only has a strong structure, but that it has a good structure – even a designed structure. One can try to run an innocent form of the architectural hypothesis, where the techniques of architecture are only used to attempt to model the phenomena of the *cosmos*, with no suggestion that the *cosmos* is designed. One might also argue that it is anachronistic to impose any modern form of the argument from design here. Nevertheless, there must still be a strong possibility that if Anaximander was influenced by architectural techniques, one reason for

was that he considered the *cosmos* to be the subject of design, or at least some form of steering or governance that was analogous to design.

Politics

I am happy with the idea that the re-formulation of political space around Anaximander's time may have influenced his re-formulation of ideas of physical space. The key idea here is that the rise of the Greek independent city, the *polis*, and of the *agora* as the central meeting place of equals forged a new conception of political space which was mirrored in a new conception of physical space. The essential contrast here goes back to Vernant, who compared the political structure of the old Oriental monarchies with the structures of their cosmologies and the nature of the Greek polis with Anaximander's cosmology.³⁴ In each case he found parallels between the political structure of the society and the structure of the cosmology. Political power in the monarchies flowed downward in a linear fashion, which was reflected in the cosmologies, while in the Greek *polis* it radiated out from the centre, as reflected in Anaximander's cosmology. The *agora* was a meeting place of equals where anyone could address those gathered there as long as they stood in the middle. Everyone arrayed around the speaker had an equal political relationship with the speaker. There is a strong emphasis on centrality and equality. Clearly, there are important parallels here between this new formulation of political space and the way that Anaximander's cosmology is constructed, particularly the emphases on centrality and equality.

There are a number of things to say in favour of this hypothesis. It is well attested that models of how the *polis* works, or how it ideally should work, were used to help model how the *cosmos* works. The politics hypothesis is well grounded in this history and politics of the period.³⁵ A similar point from a different perspective is that a cosmology could be used to legitimise a political framework. In the extant fragment Anaximander uses the language of civil law to describe the fundamental working of the *cosmos*. If I am correct in seeing allusions to Theognis and Solon in the extant fragment, or even just more generally to a background of civil strife, Anaximander's cosmology may project an ideal of a stable *cosmos* based on permanently stable fair exchange. It may also project the idea of a stable political structure paralleled by the stable nature of the *cosmos* based around a central entity with equal relations to whatever surrounds it.

Seaford has recently extended this view, arguing that the introduction of money in this period was also influential on Anaximander. The reciprocal justice

of Homer is replaced by systematic and impersonal *cosmos* which places limit and order on reciprocity.³⁶ Money generates the notion of abstract value extended in space and time which is reflected in Presocratic cosmology.³⁷ Also significant here is the idea of the symmetrical, centred political space of the *polis* and *agora*, which may be influential on Anaximander's conception of the earth and its stability, which might be thought exist in an unlimited monetary space. I would note here that money, while in a sense unlimited, is still finite.

However, as with the architecture hypothesis, the political hypothesis is less convincing on how the specific numbers are generated out of political considerations. Naddaf says that:

The three social groups, perceived as equals (*isoi*), could each correspond to a celestial ring whose numbers translate the same relation of equality, symmetry and reciprocity, 9 ($1 \times 3 \times 3$): 18 ($2 \times 3 \times 3$): 27 ($3 \times 3 \times 3$) or 1:2:3, in relation to the earth as the three social groups in relation to the *agora*.³⁸

One issue with the question of social groups is that we have no idea at all what Anaximander thought on these issues. A particular concern here is that we do not know if Anaximander would have seen his society as composed of three groups. With Plato, for instance, in the *Republic* we have a very clear idea of the groups in society and the relations between them. We have nothing of this sort for Anaximander. As Naddaf phrases it, the social groups could have these relationships to the celestial wheels but nothing forces this; in particular, nothing seems to determine the specific ratios between the earth and the celestial wheels. One important point of difference between Naddaf and myself is this. Naddaf comments that:

I do not see the *apeiron*, as many do, as governing, so to speak, the world order. If this were the case, the *apeiron* would be akin to Hesiod's Zeus, a *monarchia*.³⁹

I do see the *apeiron* as governing or steering the *cosmos*, both as an issue of the origin of the *cosmos* and as an issue of its ongoing stability. We have seen that the influence of the *apeiron* may be quite extensive. There would be important distinctions to be drawn with the rule of Zeus, notably on issues of cosmic justice, invariance and explanation in terms of the natural, but the *apeiron* would govern as a monarchy, albeit one that was committed to justice and equal relations between its subjects. One problem for Hahn's account may be how the *cosmos* acquires and maintains the level of order supposed by the political hypothesis in the absence of such direction from the *apeiron*. A further consideration here would be to differentiate between the ways that *kubernēin*

(to govern/steer) and its cognates are used in these situations. We have Plato in the myth of the *Politicus*: a single god doing the governing/steering, with his hand on the tiller.⁴⁰ Parmenides also has a sense of a single deity steering everything.⁴¹ However, we might contrast those uses of *kubernēin* with uses in Heraclitus and in the Hippocratics. Heraclitus says that:

All things are steered through all.⁴²

So, too, the Hippocratic author of *On Regimen* says that:

In a word, everything was arranged (*diakosmêsato*) in the body by fire, in a manner suitable to itself ... The hottest and strongest fire, which controls (*epikrateitai*) all things, manages everything according to nature (*kata phusin*) ... This steers all things though all (*panta dia pantos kuberna*) both here and there and is never still.⁴³

Here, one might suggest, matters are somewhat more democratic if all is steered by all. Which of these camps does Anaximander fall under? I would suggest that he lies closer to the democratic view here. The *apeiron* surrounds and steers. So political/cosmic power is not vested in one individual, but in the mass which surrounds the centre. So politically decisions flow from the masses surrounding the centre of the *agora*, in cosmic terms the steering comes from that which surrounds. The notion of steering, and steering which continues to control the *cosmos*, can then be made to fit quite neatly with the political move away from monarchies and the intellectual move away from linear cosmologies.

With the political hypothesis, I would again note that the *cosmos* would seem to have a considerable amount of structure. Especially if that structure is seen to encapsulate some form of political ideal, one would again think there was some form of design behind the origins and maintenance of the *cosmos*.⁴⁴ One could try, as with the architectural hypothesis, to run an innocent version of the political hypothesis. Anaximander simply used political analogues to try to understand the phenomena of the heavens. However, one is again left with a strong sense that if the political hypothesis is correct, that there is a fairly strong form of steering or governance behind the structure of the *cosmos*. As with the architectural hypothesis, one can argue that the political hypothesis supports the idea of a perpetually stable *cosmos*. The organisation of the heavens is based around a political ideal, one that may well see political stability as important. Given the political strife of early Greece, that is highly likely. If I am correct in seeing the extant fragment as an allusion to or a reaction to Theognis and Solon, then Anaximander would value political stability very highly. So perpetual

stability may well be one of the political ideals projected into Anaximander's *cosmos*. This is important relative to the previous chapter, where I suggested that astronomical detail was perhaps not the primary concern in Anaximander. One objection that has been raised against the political approach to cosmology is that there was no *agora* in Miletus in Anaximander's time, one counter to which is that Anaximander seems to have been well travelled, along with the by now standard comment that he was imposing ideal and not actual political relations on cosmology.

Teleological cosmology

With any teleological cosmology, what is the end state which is envisaged? What is preferable about this end state in relation to others? Where we have a teleological cosmology being generated, there is an issue of criteria for the agency which is generating the *cosmos*. Why choose to generate this state of affairs rather than another state? Plato's *Timaeus* is admirably clear on these issues.

For god desired that all things should be good, and nothing paltry as far as was possible, he took over all that was visible, which was not at rest but in discordant and disorderly motion, and led it into order out of disorder, judging the former to be entirely better than the latter.⁴⁵

The demiurge aims to generate the best arrangement of the *cosmos*. The *Timaeus* also attempts to explain why the proposed arrangement of the *cosmos* is good in each case. It is also notable that the demiurge, being good and wishing nothing but the best for the *cosmos*, will not allow its dissolution. Anaximander may have wanted a specific sequence of numbers for the proportions of his *cosmos*, as they give the steering principle something to steer for just as the proportions derived from the musical scale give the demiurge criteria for how to space the orbits of the sun, moon and planets in the *Timaeus*.

Am I attributing a 'harmony of the heavens' here to Anaximander? No. There is nothing musical, or musically derived about Anaximander's sequence. I would say, though, that the spacing of the wheels is designed to promote maximum stability in the *cosmos* with neither the earth nor any of the wheels having any reason to change its position in any particular direction. In that sense there is a specific structure to the heavens, but it is not a harmony in the sense of the Pythagoreans, Plato or Kepler.⁴⁶

Am I attributing a teleology to Anaximander? No and yes. In the sense of where do we find the first fully worked out, thoroughgoing teleological account of the *cosmos*, my answer would be in Plato's *Timaeus*. There are, though, in my view, end-directed elements in Anaximander's cosmogony and cosmology, so in this sense I would say that he is a teleologist. Is there teleology before Plato? *Philebus*, 28d seems to recognise that there is and as we have seen earlier, Heraclitus, Parmenides and the Hippocratic authors all use *kubernein* in important cosmological contexts. We are quite wrong, in my view, to focus solely on Plato's critique of Anaxagoras in the *Phaedo*, fascinating and important though that is, in relation to precursors to Plato's teleology. Plato himself seems to recognise an important tradition prior.

In relation to this issue of teleology, I raise the issues of the stability of the *cosmos* once more. Plato is admirably clear on this matter. In the *Timaeus*, the demiurge will simply not allow a good *cosmos* to be dissolved.⁴⁷ This view is well attested by Aristotle, not least because he believes it to be fundamentally flawed.⁴⁸ The *cosmos* of the *Timaeus* will not degenerate of itself.⁴⁹ In the *Timaeus*, the *cosmos* is *agêrôn kai anoson* 'ageless and unailing'.⁵⁰ In the *Politicus*, when the helmsman god takes over control of the disintegrating *cosmos*, he makes it *athanaton* and *agêrôn*, 'deathless and unaging'.⁵¹ If Anaximander has the *apeiron* steer the *cosmos* into existence, and gives it a considerable amount of *taxis*, why would that steering principle then allow the *cosmos* to degenerate? Do any of the Presocratics who use *kubernein* suppose the *cosmos* to degenerate? I would say no. If there is ongoing guidance, one must always worry as to why it would allow the degeneration of the *cosmos*, especially if its establishment is seen as something good.

In Plato, teleology is related to intelligibility. The world is not a random jumble, but has been set up in such a way that we humans can understand it. The basic triangles, for instance, are not just random triangles, but a specific type which are seen as the best types. We do not have enough of Anaximander's epistemology or indeed his philosophy more generally to be able to judge whether intelligibility was an issue for him, but if the *apeiron* steered towards a specific goal of a set structure for the *cosmos*, that has to be a possibility.

Oriental cosmology?

West has suggested several Oriental elements in Anaximander's cosmology. He begins by discussing the possibility that the earth is concave, in which case it

might be thought that the inhabitable centre of the face of the earth was surrounded by mountains.⁵² The evidence here is from Hippolytus, *Refutation of All Heresies*, I, 6, 1–7, with the likely meaning that the earth is concave.⁵³ The inhabitable earth does not need to be surrounded by mountains, however. The shape of the earth may, in one sense, be concave, but if that depression is filled with water, as seems likely, then there is a sense in which the earth is simply pill shaped and the idea of surrounding mountains simply vanishes.⁵⁴ West also argues that:

Before Anaximander, the sun and the other heavenly bodies had been treated as detached, self-contained entities moving free from earth to heaven and back again. Anaximander attaches them to invisible wheels running right around the earth.⁵⁵

West finds a precursor to this in Ezekiel where, according to West, there were Cherubs attached to wheels forming the machinery of the heavens.⁵⁶ Given the evident circular motion of the stars, I would suggest that the idea of a wheel would be reasonably ubiquitous. Second, Anaximander did not attach the heavenly bodies to wheels. The heavenly bodies are wheels, for the most part invisible, we humans seeing the core of fire of these wheels through a small aperture. If Anaximander was aware of previous models using wheels, he works a significant transformation on them.

There may well be Persian or other precedents for the order of stars, moon and sun that we find in Anaximander.⁵⁷ It is possible that Anaximander was aware of these and they influenced him some way. There is another consideration here though, which is that if we have the scheme of fire enclosed in compressed air for the heavenly bodies, and if we can see the sun through compressed air which is sufficiently opaque to obscure the ring of fire of the stars, then of necessity this must be the order.⁵⁸ The brightest body must be furthest away, the next brightest the next furthest away and the stars nearest. So contrary to West, there is a 'scientific consideration' for Anaximander for the order of the heavenly bodies.⁵⁹ West also suggests that the order is based on:

Religious conceptions of fiery purity as one ascends from earth to heaven.⁶⁰

There is no need for any religious conception here in Anaximander. As we have seen, there may be a greater concentration of fire in the sun ring, but as it was generally held that fire rises, this cannot be any great surprise. I see no reason to go in for any idea of the purity of fire in Anaximander. I would emphasise that it does not matter where Anaximander got ideas from, it is what he does with them

that matters. While there is often an eschatology bound up with mythological accounts of the heavens and the order of the heavenly bodies, there is none with Anaximander.

Finally, West draws some parallels with Egyptian and Babylonian cosmologies which use the number 36. The idea here, as we have seen earlier, is that we might add 36 to Anaximander's 1, 3, 9, 18, 27 sequence. This assumes that the sequence is extendable to 36, for which there is no textual and very little theoretical support. I see little here to suppose any significant influence of Oriental cosmology on Anaximander. If there were any influence, it would seem that Anaximander wrought a significant transformation on those ideas.

Oriental cosmogony?

West has also claimed some influences from Oriental cosmogony on Anaximander. He cites both Iranian and Indian sources for the idea that worlds come out of the infinite and perish back into it.⁶¹ In reply to this, my first comment is that this is not how I see Anaximander's cosmogony, rather a *cosmos* is generated out of the *apeiron* (which I would argue has significant differences from any Oriental conception of the infinite) but that *cosmos* is then stable. Parts may be dissolved back into the *apeiron* but these are renewed and the *cosmos* continues in perpetuity. So similarities with Oriental cosmogony immediately vanish. Even if we accept the single, recurrent world theory for Anaximander, I am by no means convinced there is any demonstrable influence from Oriental cosmogony here. The notion of generation of a world or worlds from the infinite is both vague and ubiquitous and can be found in many cultures.

Nor do I see that much can be made of Anaximander theorising something like an egg or something like the growth of a tree in the early phase of cosmogony.⁶² If we keep these ideas suitably vague, of course one can find similar ideas prior to Anaximander. Again, such ideas are ubiquitous and can be found in many cultures. An interesting question is if an idea, such as an egg for the origin of the *cosmos*, can be found in many cultures, do we need to seek a unitary source for that idea and then demonstrate how that idea could have promulgated to all the cultures who have it?⁶³ Ultimately, I have some historiographical differences with West, who concludes by saying:

Coincidence is excluded. Anaximander's conceptions cannot be derived from Greek antecedents, and to suppose that they chanced to burgeon his mind

without antecedents, at the very moment when the Persians were knocking on Ionian doors, would be as preposterous as it was pointless.⁶⁴

I do not think that we can exclude coincidence here if there are affinities between Anaximander and Oriental sources in cosmogony and cosmology. Some ideas in cosmogony and cosmology are ubiquitous, especially when expressed in a very general or vague manner. I do not see that any of the affinities suggested by West are specific enough to rule out coincidence.

Can Anaximander's ideas be derived from Greek antecedents? To some extent, yes. Recent work on the architectural hypothesis and the political hypothesis has shown important sources and influences for his cosmology. The Hesiod hypothesis locates an important influence in early Greek thinking. To some extent, though, Anaximander's transformation of these formative ideas is original to him and cannot be derived from any antecedent, Greek or otherwise. This is not to deny either the importance of Oriental cosmogony and cosmology or the possibility of any influence from Oriental culture to the Greeks. It is certainly there in architecture, it may well be there in other disciplines, but Anaximander is not indebted to any specific Oriental idea in cosmogony or cosmology.⁶⁵

Plato allusion?

Could the following passage from Plato, *Gorgias*, 507e–508a, be an allusion to Anaximander?⁶⁶

Wise men claim that partnership and friendship, orderliness, self-control, and justice (δικαιοσύνη) hold together heaven and earth, and gods and men, and that is why they call this universe a world order, and not an undisciplined world-disorder. I believe that you don't pay attention to these facts, even though you're a wise man in these matters. You've failed to notice that proportionate equality (ἡ ἰσότης ἢ γεωμετρικὴ) has great power among both gods and men, and you suppose that you ought to practice getting the greater share. That's because you neglect geometry.⁶⁷

On the deflationary side, one might say that the reference to 'wise men' here may simply be Plato's poetic way of introducing these ideas. Alternatively, the talk of geometry may mean that Plato has the Pythagoreans in mind. The case for Anaximander being alluded to here would be the reference to justice holding together heaven and earth; the reference to proportionate, geometrical equality

is precisely what we find in Anaximander's numbers. I would also note that this is a positive reference to these 'wise men' and that all the cases for an allusion to Anaximander in Plato seem to have been positive towards him.

Conclusion

Why did Anaximander adopt this specific sequence of numbers for the proportions of his *cosmos*? They are not derived from astronomical observation, though to a considerable extent they have consequences which are in accordance with observations of the heavens. It would not seem that this sequence of numbers can be generated from considerations relating to an influence from either architecture and building practice or from the political reformulations of Anaximander's time. This is not to say that neither had an effect on Anaximander.⁶⁸ On the contrary, I would suggest that both are of considerable significance in enabling the formulation of this sort of cosmology even if they cannot supply the specific proportions of the heavens for Anaximander.

However, there are also important areas where Anaximander appears to transform both of these traditions in generating his *cosmos*. The specific number sequence that Anaximander adopts cannot be derived from architectural or political considerations. In relation to the discussion of the possible tensions between astronomy and cosmology in the previous chapter, I would add here that Anaximander's primary concern in his model of the heavens is stability and the transformation of the use of the $9 + 1$ formula rather than the details of astronomy. The projection of a political and architectural ideal on the heavens would also seem to take precedence.

If Anaximander did have the Hesiod bronze anvil passage in mind, not only do we get the sequence of 9, 18, 27, we also get the further numbers of 10, 19 and 28 as well as part of the Homer/Hesiod $9 + 1$ formula for a long time/distance followed by closure. We have no need to look for any mystical significance for the sequence drawn from outside early Greece. On this view, Anaximander's proportions for the *cosmos* would definitely be radii. There are transformations here, too, of course. Anaximander treats $9 + 1$ as modular, where Homer and Hesiod most definitely do not; of course, there are significant moves away from the sort of universe that Homer and Hesiod envisaged.

A further way of thinking about Anaximander's number sequence is in relation to teleology. If the *apeiron* steers the *cosmos*, it must steer towards something. Here is a sequence of numbers which give the *cosmos taxis* and

stability. This is not to say that Anaximander's supposed teleology is as ramified as Plato's or that Anaximander went in for a harmony of the heavens. It is merely to suggest that these numbers, which would generate equality and stability in the *cosmos*, give the *apeiron* a goal to steer towards.

We do not need to look beyond the context of ancient Greece for the sources for Anaximander's cosmology. The relation to architecture, politics and to Hesiod goes a long way to explaining the influences and inspiration for Anaximander's cosmology. There are some vague affinities with some Oriental cosmologies, but no more than one would expect. Some cosmological ideas are ubiquitous, especially when expressed in a very general manner and I do not see any specific Oriental idea which had a significant influence on Anaximander.

Anaximander's numbers bestow a significant amount of *taxis* and stability on the *cosmos*. The celestial wheels are not only well constructed, they are well spaced. There is no reason either for the earth to move or for the celestial wheels to move from their positions. If we reject the terminal drying out hypothesis, there is no reason we know of for Anaximander's *cosmos* to deteriorate. If we factor in the ongoing action of the steering principle, in fact there is a reason why it should remain stable.

Conclusion

This book has offered a comprehensive re-assessment of Anaximander. That re-assessment has led to an Anaximander more heavily reliant on biological analogues in cosmogony and cosmology, and for whom steering plays an important and ongoing role. It has led to a single *cosmos* for Anaximander, rather than many worlds at the same time or many worlds in succession. It has led to a simpler, astronomically less sophisticated *cosmos* for Anaximander, but one which is more symmetrical and stable, and which displays considerably more good order. We have an Anaximander with fewer superficial similarities to modern scientific theories, but with theories of greater epistemic merit and contextual plausibility. We also have an Anaximander who is self-consciously different from and critical of the preceding poets, especially Hesiod, and who is also significantly different from the early atomists.

I am aware that some aspects of my interpretation of Anaximander rely on relatively little evidence, although that is a universal issue as we have so little evidence. I hope to have produced a coherent and integrated view of Anaximander and one that is sensitive to his context, by examining and integrating a broad range of passages. I also hope to have highlighted the key historiographical issues in dealing with the evidence we have, some of which have been tacit in previous work.

This book has tried to introduce two varieties of new evidence, supposed allusions by Anaximander to preceding poets and supposed allusions by later thinkers to Anaximander. The lead instance is Anaximander on meteorology and the battle of the gods and giants in Hesiod's *Theogony*, though Anaximander on the proportions of the *cosmos* and the dropping anvil passage of the *Theogony* would not be far behind. I have also suggested that there are allusions to Homer on the unageing, undying gods, Terpander on the functions of Zeus, Theognis on fair exchange and *cosmos*, and Solon on Time. Allusion is both difficult to prove and to interpret. I would argue that each of the candidate instances here are plausible relative to accepted instances of allusion. They allude to passages which would have been widely known, would have been formative of attitude and are significant relative to what I have suggested Anaximander is trying to say. Allusion is, of course, no guarantor of attitude and passages may be alluded

to for a variety of purposes. One might also suggest that with a sufficient amount of poetry pre-Anaximander, it will be possible to find some similarities or possible allusions but those are in fact mere chance occurrences. However, I would suggest that Anaximander's allusions do have a pattern. First, there is the transfer of functions or epithets of the gods, these being taken up either by the *apeiron* (unageing, undying, steering) or by natural explanation within the *cosmos* (meteorological phenomena). Second, there is the transformation and critique of previous views, either on natural explanation or cosmic/political stability which also form a pattern. I have argued elsewhere that there was a broader Presocratic pattern of allusion to Homer and Hesiod in relation to the natural explanation of phenomena.¹ Anaximander fits that pattern well and may be the instigator of this method; several Presocratics give natural explanations for the five meteorological phenomena given by Anaximander. If Anaximander did make these allusions, this tells us a good deal about his philosophy and provides a context for his work. It makes him consciously different from the earlier poets.

On later thinkers alluding to Anaximander, it is commonly accepted that Heraclitus, Fr. 80 does so. Plato is clearly alluding to someone at *Philebus*, 28d when he speaks of those of old who thought that the *cosmos* was steered. As we have seen, that could be a number of people that employed the steering metaphor, but I would be inclined to include Anaximander in that group, as the most famous of the early steerers. There are possible allusions in the *Timaeus* and *Gorgias*. I have argued that the *Phaedo* reports Anaximander's view (round earth, indifference argument) and then builds on it (spherical earth, indifference argument). If so, that solves a problem about the shape of the earth in the *Phaedo*. Plato is reporting Anaximander's view of the earth as round while his own view is that the earth is spherical: with either shape, the indifference argument works, according to Plato. This passage, taken in tandem with Aristotle's report, which also has the earth in the centre, indicates that both Plato and Aristotle ascribe a finite and probably spherical *cosmos* to Anaximander.

Whether Aristotle and Theophrastus had sight of all, some part or none of Anaximander's texts is not a question we can definitively settle on the current state of the evidence. I have given some reasons to be sceptical of whether they had all the texts in front of them and for the purposes of this book have made the methodological assumption that they did not. The alternative here is that Anaximander wrote, his works were lost, in full or in part, but remembered through an oral tradition, which is, in full or in part, what Aristotle and Theophrastus rely on. There must be a similar oral tradition, or we would know nothing of Thales. This has allowed a rather broader re-evaluation of some of the

evidence of Aristotle and Theophrastus. As I have emphasised, we need to, and can, make judgements about that evidence even if we believe they had the texts, as not all the evidence is reliable. There is no free for all if we reject the idea that Aristotle and Theophrastus had sight of Anaximander's texts, but there is some more scope for making qualified judgements of the worth of their evidence. That, in my view, has been an approach well worth investigating.

I have been keen to avoid two assimilations in this book: of Anaximander to Hesiod and the poetic tradition and of Anaximander to the early atomists. I hope to have shown that there were significant differences between Hesiod and Anaximander. If it is the case that Anaximander alluded to Hesiod, then Anaximander consciously distanced himself from Hesiod and actively transformed aspects of his thought. Certainly Anaximander's *cosmos* is a very different place to the world of Hesiod and is explained in very different ways. I have argued that we see something similar in the way of transformation in relation to Homer, Theognis, Terpander, Pindar and Solon. I have been keen to emphasise the differences between Anaximander and pre-Greek cosmology and cosmogony. I have argued that the supposed similarities are too vague and generic to be meaningful and that the key developments on Anaximander (free earth, no sky, full orbit around the earth) have no precedents.

The possible assimilation to Leucippus and Democritus is perhaps the more insidious. If we accept the doxographical evidence on multiple worlds, it is then a reasonable strategy to see if we can attribute the philosophical and cosmological apparatus which would support the idea of multiple worlds, which naturally drags Anaximander closer to Leucippus and Democritus. This strategy also has the supposed advantage of making Anaximander more mechanical and supposedly more congenial to modern science. However, I hope to have shown there to be significant differences between Anaximander and the early atomists. Some of these either are, or should be, uncontested. So Anaximander, in contrast with the early atomists, had a steering principle, is a pre-Parmenidean and does not have an atomistic conception of matter, did not employ the *ou mallon* principle in relation to matter, space or time, did not have infinite space, did not have any cosmic vortices, did not employ a like-for-like principle and his conception of cosmogony was more biological than mechanical. On the latter point, it is again important to avoid an assimilation, this time to the Orphics and others who use biological metaphors. Anaximander clearly uses those metaphors in different, more sophisticated ways. On my account, then, there is clear water both between Anaximander and the poets and the pre-Greek cosmologists, and between Anaximander and the early atomists.

This book might be accused of assimilating Anaximander too closely to Plato. Certainly I have suggested some ideas in Plato for consideration in relation to Anaximander and have suggested some similarities between Plato and Anaximander. So we have, in no particular order, the idea that the *cosmos* is good, that there is permanent benign steering of the *cosmos*, that the *cosmos* is generated but not dissolved, that there is finite space with the earth in the centre, and that there are some interesting similarities between the receptacle and the *apeiron* and what they argued for. This approach, I believe, is a new departure in Anaximander scholarship and has been motivated by two considerations. I have argued that Plato alluded to Anaximander in several places and that when he did it was a positive allusion; that gives us some interesting information, certainly about Plato's perception of Anaximander, possibly about Anaximander himself. Second, there are places in the evidence where Plato, or recognisably Platonic views are mentioned in association with Anaximander, indicating that the ancients, too, perceived some link or similarity.

Of course, care needs to be taken here and there are significant dissimilarities as well. The *demiurge* acts in a different way to the steering principle, there are important differences between receptacle and *apeiron*, and in Anaximander there is no explicit teleology. Plato may well have his own agenda in alluding to Anaximander and for his own purposes may wish to overplay the extent to which steering has foresight or consciously envisages a goal. Considering Anaximander as a forerunner to Plato, even a forerunner recognised by Plato, is a worthwhile exercise if only as an interesting antidote to assimilating Anaximander too closely to Leucippus and Democritus

Anaximander may well have referred to the *apeiron* as *to theion*, the divine, though there is room for reasonable doubt on this matter. If he did, I have argued, that is of no great consequence. The *apeiron* is part of nature and behaves in an invariant manner. There is no need to generate a religious interpretation of Anaximander that downplays the scientific elements of his thought or for any scientific account to either downplay or deny the *to theion* description. Modern historiography of the relation of religion and science has dispensed with such an approach. Crucially in Anaximander, we have a detailed, carefully thought out cosmology, but we have no heaven, no Hades/Tartarus and no eschatology. Anaximander is best classified as a pantheist, though that is a very broad classification which is in need of some further elucidation. Pankubernist is perhaps the most accurate of the pan-descriptions, but there is a question of whether the *cosmos* steers and so whether pan-, in the strictest sense is applicable, even if at first attempt it gives a reasonable description of Anaximander.

It has been questioned whether Anaximander actually used the terms *cosmos* and *phusis*. What should be evident from the preceding chapters is that whether he used the terms or not, Anaximander's treatment of the world is entirely in line with the Presocratic notion of *cosmos* as a well-ordered, regular universe. So, too, his investigation of that world shows all the aspects of the Presocratic investigation concerning nature tradition. Anaximander had an account of the origins, development and current state of the *cosmos*. He had an account of the origins of life in general and humans in particular. We now see that Anaximander had an account of many of the meteorological phenomena of the current *cosmos*, as well as being able to give an account of the origin of those phenomena. We should have no hesitation in using that term in relation to Anaximander as well. It should be evident, though, that if we take *phusis* in the sense of origin, growth and current disposition, Anaximander wrote about what later Presocratics would happily call *phusis*.

Anaximander's *cosmos* shows considerably more *taxis* than it is often given credit for. Stars, moon and sun each have a specific and well-organised nature, being constituted out of fire and compressed air. Each could be considered to be a *cosmos* in its own right, something which may be significant relative to the doxographical evidence concerning multiple *cosmoi* for Anaximander. Not only do the stars, moon and sun individually have good order, they do so collectively as well. They are well placed relative to each other as if the stability of the *cosmos* was an aim of Anaximander. The stability of the earth, I hope to have shown conclusively, is due to indifference and not support by air or by a vortex. When we take a broader picture of the relation of the heavenly bodies to the earth and the *cosmos* to the *apeiron*, only the indifference theory gives a sensible answer. One theme of this book has been taking a broader, more universal view of Anaximander. Not only do we need to think of change at the level of the *cosmos* rather than just locally, we need to think about the stability of the rings and even the *cosmos* within the *apeiron* as well as the stability of the earth. One important result here is that the equilibrium argument for the stability of the earth (and indeed any earth) is simply incompatible with co-existent *cosmoi*.

I have argued that the emphasis on the external boundaries of the *apeiron* may well be anachronistic and that Anaximander may have been more interested in internal boundaries, denying these to give a homogenous *apeiron*. Our best reconstruction, based on the central earth evidence of Plato and Aristotle, is that the *apeiron* is unlimited by anything else but is finite and spherical.

There is only one *cosmos* for Anaximander. The 'everything generated out of, everything dissolved into' formula does not establish a succession of *cosmoi*. All

the constituents may change without the *cosmos* changing. On my view of change in Anaximander, the *cosmos* as a whole cannot dry out. If it is dry here, it is wet somewhere else, but the *cosmos* cannot become completely dry and then be re-absorbed back into the *apeiron* as some have suggested. There is a plausible alternative interpretation of the drying evidence, that the earth initially is wet and begins to dry as the weather cycle is established, but once that cycle is established there is an equilibrium, again governed by the sun. Anaximander lacked the motivation as well as the philosophical and cosmological apparatus for a multiple *cosmoi* theory. The later doxography which ascribes multiple *cosmoi* to Anaximander can be traced back to ambiguity in Aristotle. I have argued that there is evidence in Aristotle that Anaximander did not postulate multiple *cosmoi* and that Aristotle does not attribute the requisite supporting ideas such as infinite space to Anaximander either. Anaximander appears to take great care in establishing stability in his *cosmos*, not only for the earth but for the celestial bodies as well. The *cosmos* is a good and just place for Anaximander. It is hard to see either how or why such a *cosmos* would deteriorate, especially if the action of steering, which brought about this *cosmos* in the first place, is ongoing. The *cosmos* acquires a great deal of *taxis* from this steering and there is no reason to suppose that the *cosmos* will subsequently deteriorate.

Mansfeld has recently argued against equilibrium in Anaximander.² Contrary to his view, I do find considerable evidence of stability and *taxis* in Anaximander.³ While the extant fragment allows local change in the distribution of the contraries, I have argued that there is no change in the relative quantities of the contraries at the cosmic level, nor could there be. If the earth is drying out for Anaximander (the evidence for it is little and dubious), then that drying may be part of the establishment of the weather cycle rather than a terminal drying out.⁴ As I take Anaximander to be a uniformitarian on zoogony and cosmogony, I do not agree there is a sharp or fundamental contrast between a cosmogonic period and now.⁵ Anaximander did indeed model cosmogony on biological processes such that the origins of the *cosmos* are like the birth of an animal or plant, but that does not entail the death of the *cosmos*, as it does not in Plato.⁶ Anaximander projected ideal rather than actual relations on the *cosmos*, and the ongoing steering principle will prevent deterioration of the *cosmos*.⁷

I have raised the issue of a tension between reconstructions of Anaximander's astronomy and his cosmological principles. A key historiographical principle is this. We cannot assume that every ancient Greek who generated a model of the heavens believed that model could account for all of the phenomena he was aware of. We can give Anaximander a complex model of the heavens, with sun

and moon rings moving on an axis through the earth, so that he could account for the seasons and varying heights of the sun and the moon in the sky. However, this would wreck the symmetry of the *cosmos* and ruin the indifference argument for the stability of the earth. I have argued it is preferable to stay with strong cosmological principles, as it is in other cases, and to give Anaximander a simpler model of the heavens, even if that cannot account for all the phenomena he was aware of.

Anaximander's proportions for the *cosmos* have provoked considerable debate. Are these numbers derived from previous cosmologies, observational astronomy, an influence from architecture or an influence from politics? I have argued that the only source that can give us these specific proportions is Hesiod, and that Anaximander is alluding to and transforming Hesiod's *Theogony* on the nature of the *cosmos*. If so, the proportions must be radii. There may also be an interesting teleological aspect to these numbers, as something specific for the steering principle to steer the *cosmos* towards in cosmogony. There were, though, political and architectural influences on Anaximander's cosmology, his model of the heavens in many ways instantiating an ideal projection of political and architectural principles.

There can be no question that the *apeiron* in Anaximander steers. Aristotle's Greek in the relevant passage, with the double 'all' (surrounds all, steers all), indicates that he is quoting or paraphrasing Anaximander; in turn, Anaximander may have been alluding to Terpander and transferring the roles of Zeus to the *apeiron*. The evidence of Plato, who praises a tradition of steering, means that if Anaximander is part of this tradition, it would be very unlikely that he had the Anaxagoras view that there was some form of intelligent control of the *cosmos* which has now stopped. It is much more likely that steering is ongoing. I have also quoted passages from some Presocratics, Plato and Aristotle, which indicate that steering could be thoroughgoing and affect all aspects of the *cosmos*. This is of considerable importance, as steering has sometimes been ignored altogether in Anaximander, or downplayed to a minor role, which is neither ongoing nor thoroughgoing. The exact nature of the steering is harder to discern. It may involve intelligence, along the lines of Plato's *demiurge* or the modern theory of intelligent design. Another possibility, given the biological analogues which Anaximander uses, is that the *apeiron* steers the *cosmos* in the same way that a seed might be said to steer or control the development of a plant.

It is possible to generate a mechanical view of cosmogony and cosmology in Anaximander (vortices, mechanical separation, etc.), though I have argued that the evidence does not support that and there is a highly plausible alternative of a

biological model. A characteristic of the *apeiron* is its ability to generate. It does so by biological secretion and there are plenty of biological ideas in the specific cosmogony. If we think there is a parallel between zoogony and cosmogony in Anaximander, we need to question the assumption that the zoogony borrows mechanical analogies from cosmogony rather than cosmogony borrowing biological analogies. Metamorphosis may play a significant role in the cosmogony as well as the zoogony. Once we recognise the possibility of a positive, biological version of Anaximander, there are new ways to look at passages and ideas. We may well have been too swift to consider the celestial wheels to be rigid and mechanical rather than more fluid and organic.

On the *apeiron* and the extant fragment, I have argued that we need to take a broader view of change in Anaximander. If it is hot here, that does not give us preponderance of the hot in the *cosmos*. The way to think of this is that if it is hot here, it is cold somewhere else, just as if it is day or summer here, it is night or winter elsewhere. Anaximander is the first to have a cosmology to support such a view, with the sun going right around the earth. This view I have termed sunchronic, with contraries like hot and cold always produced or dissolved in matching pairs, in opposition to the diachronic view, which has differences in the production of the hot and the cold made up over time. There is still a cycle of change such that night and day recompense each other over time, but this is simply driven by the motion of the sun, which gives us the 'according to the order of time'. This proposal has been remarkably good in clearing up puzzles relating to the extant fragment. One consequence of this view is that the *cosmos* cannot dry out terminally. A concern about steering, that it is not immanent in nature, or that it is metaphysical, vanishes when we take the broader perspective here and recognise that the *apeiron* is part of *phusis* for Anaximander, as it must be as the *archè* of the *cosmos*. There are no vortices in Anaximander. The supposed evidence does not implicate Anaximander, and Anaximander has neither a need for vortices nor, as a pre-Parmenidean, the conception of matter needed to support the idea of vortices.

I consider the quality of Anaximander's theories to be high given their context. There can be no question that Anaximander was a natural philosopher and that, in the context of sixth-century BCE Greece with the background of Homer and Hesiod, is no small feat. All explanations of phenomena, including critical phenomena such as eclipses and earthquakes are explained in a natural manner. The five meteorological phenomena are given natural explanations in stark contrast to Hesiod. Anaximander also gives explanations of the key issues of cosmogony and zoogony in entirely natural terms.

Were these theories founded on faith or bluff in their attempt to explain the phenomena?⁸ Anaximander's theories had considerable epistemic merit. They had breadth. Anaximander explained all of the phenomena of thunder, lightning, thunderbolts, hurricanes and typhoons in terms of wind. They were invariant, phenomena always occurring in the same manner for the same reasons. Invariance might seem a small merit in relation to modern theories, but in context this is enormously important in relation to Hesiod and Homer. They had depth. Wind explains the meteorological phenomena, but there is also an explanation of the nature of wind and an explanation of the origin of wind. They had coherence and parsimony. The theme of bursting accounts for not only some meteorological phenomena but also phenomena in cosmogony, zoogony, astronomy and cosmology. Do these theories lead to new predictions and explanations? Yes, we have concrete evidence for that in Anaximenes' extension of the theory and Plato's adoption and improvement on the flat earth stability argument in the *Phaedo*. It is also significant that several Presocratic philosophers after Anaximander discuss the five meteorological phenomena in natural terms.

Are Anaximander's theories based on and compatible with observation? To a surprising extent, yes. One could hardly expect a meteorological theory at this stage to be based on experimental evidence. Anaximander's theory is compatible with ordinary observations though. A key point here is that for Anaximander, the processes by which the *cosmos* was formed and by which life began are to some extent still going on around us and open to observation. If the Caddis fly hypothesis is correct, then there is a need for a radical re-assessment of Anaximander's zoogony. It is no longer a 'genial fantasy',⁹ but based on observation and folk knowledge. Anaximander's ties to folk knowledge and practical knowledge such as architecture are an important theme for this book.

It is interesting that we can see a uniformitarian approach from Anaximander in both zoogony and cosmogony. That consistency at least suggests that Anaximander made a conscious decision at the meta-theoretical level to form theories in this manner. Whether uniformitarianism is a merit in itself is something which is open to debate, especially as current theories of the origins of the universe are not uniformitarian. However, it is important that Anaximander does this sort of second-order theorising and so, to some extent, engages in the philosophy of science. It is also significant epistemologically that Anaximander is prepared to presume that what we see may not reveal the actual structure of the world, as with the relation of what we actually see in the heavens to the celestial rings.

One of the themes of this book has been that if we are willing to drop some of the supposed similarities between Anaximander and modern science and some of the supposed sophistication of his model of the heavens, we actually get a more interesting picture of Anaximander. So, in zoogony, we have an interesting account involving metamorphosis rather than a supposed evolutionary account. The simpler model of the *cosmos* allows for greater symmetry and stability. This is so at another level as well. If we drop the attempt to give Anaximander some forerunner of atomist or mechanical world views, we then can have greater use of biological analogues in cosmogony and cosmology and can have a civil law view of regularities for Anaximander. None of this on modern historiographies demeans Anaximander's achievements and these sorts of views seem rather more plausible in context.

Do I distance myself from the idea that Anaximander was doing science? My answer to that would be a definite no, though with some qualifications. I would prefer to use the ancient terminology of someone who practised the investigation concerning nature than the modern term scientist, though I am happy – with due qualification – to call Anaximander a scientist or a natural scientist given his emphasis on natural explanations. I have denied superficial similarities with modern scientific theories but have attributed theories which were more plausible in their context and which have greater underlying epistemological merit. Anaximander may have called the *apeiron* the divine, but that is unproblematic given the modern historiography of the relations between religion and science. His conception of the world may have been biological and he may have believed in some form of steering but these ideas in context are unproblematic with modern historiographies. Nor do I think that seeing greater affinities with Plato than with the early atomists distances Anaximander from science or the investigation concerning nature.¹⁰ If we mean by science something which is antithetical to any religious belief and is exclusively mechanical, then Anaximander is perhaps not doing science. However, such a conception of science is rigid, narrow and outdated; in my view, Anaximander does something very interesting within a broader conception of science.

I have made a case for a slightly different Anaximander, more biological in his approach, more dependent on the steering principle, with greater order and stability in a single *cosmos*, someone who alluded to and differentiated himself from the poets and who was an important transformational thinker. On my account, Anaximander has superficially less in common with modern scientific theories, but his theories have greater epistemic merit than is generally thought. There can be no question of proof here, as our evidence is too meagre and too

contested. What I hope to have done is put forward a coherent picture of Anaximander, to show how the specific views I have argued for relate to each other and that they give a viable, attractive overall picture of Anaximander. I also hope to have incorporated recent insights into Anaximander, introduced new methods and evidence and to have re-assessed Anaximander in line with recent advances in historiography. Whether the reader ultimately agrees or disagrees with what I have argued here, I hope to have raised and discussed a key question for Anaximander historiography: why do we like or dislike certain interpretations of Anaximander?

Addendum

Apertures

At various points in this book I have been critical of mechanical interpretations of Anaximander and have commented that even those sympathetic to a more organic reading have sometimes failed to escape from mechanical language or metaphors. Now for some self-criticism. In at least one respect, I have failed to escape from mechanical analogues as well. I have used the term 'aperture' for the holes in the celestial rings. I now think this is inappropriate and would rather use the terms 'mouths'. Aperture, with the related connotation of a camera shutter closing so giving eclipses and phases of the moon for Anaximander, is fine in some ways but I now think it too mechanical and too inflexible. The idea that the celestial rings might in some sense be fluid, being air and fire, rather than rigid, came to me late in the writing of this book, much later than the decision to use 'aperture'. It seems to me now that a more appropriate term with that conception of the rings is then 'mouth', like the mouths of animals. The mouth can then take on many configurations, from a normal round to shut with many shapes in between to give eclipses and phases, and can change from completely open in any direction, unlike a camera shutter. I could possibly have gone back through the proofs changing aperture for mouth. Actually, I think this is best treated in an addendum as indicative of an ongoing attempt to re-think mechanical and organic approaches to Anaximander.

Notes

Introduction

- 1 See Diogenes Laertius, *Lives of the Philosophers*, 2, 1–2.
- 2 See KRS p. 76 and p. 76 note 1.
- 3 Themistius, *Orations*, 26, 317c.
- 4 See Graham (2010) p. 66, Schmalzriedt (1970), KRS p. 103 note 1.
- 5 *Suda*, alpha 1986, 1 ff.
- 6 Guthrie (1952) p. 73, cf. Graham (2010) p. 66, KRS pp. 102–3.
- 7 Agathemerus, 1, 1, Strabo, *Geographica*, 1, 1, 11, cf. 1, 1, 1 and 14, 1, 7.
- 8 Eusebius, *Preparatio Evangelica*, X, 14, 11.
- 9 See Diogenes Laertius, *Lives of the Philosophers*, 2, 1–2, above.
- 10 Aelian, *Various History*, III, 17. Though see here West (1971b) p. 76 note 1 for discussion on authenticity.

1 Anaximander and Historiography

- 1 Couprie (2011) p. 96.
- 2 Dicks (1970) pp. 45–6.
- 3 Cf. Couprie (2003) p. 167: ‘For reasons such as these, I think that there is no use in trying to give a coherent, overall exposition of Anaximander’s teachings.’
- 4 Here I would disagree with Seaford (2004) p. 202 who equates physical and cosmological law and believes we do not find this in the Presocratics – in my view moral/political or organic conceptions of law can be cosmological (invariant, universal) and can be found among the Presocratics.
- 5 The verb is *kubernēin*, to steer or to govern, Aristotle, *Physics*, III/4, 203b.
- 6 See Kahn (1960) pp. 5–7 on the advent of rational thought, Kahn (1960) p. 8 on the Anaximander fragment and natural law.
- 7 Gregory (2013a) Ch. 1.
- 8 Cf. Lloyd (1970) pp. 12 ff.
- 9 West (1971b) p. 77.
- 10 Draper (1874) *History of the Conflict between Religion and Science* and White (1896) *History of the Warfare of Science with Theology in Christendom*. The book titles may give some indication of their orientation! In the complexity model,

religion and science may clash, may be neutral or indifferent to one another, or may aid each other given the specific situation.

- 11 Cf. Mansfeld (2009) pp. 11 ff.
- 12 Barnes (1982) p. 20.
- 13 One might also be concerned about importing technical notions of infinite extent prior to Zeno.
- 14 See Kirk (1955) p. 32: 'Parmenides forced scientific dogmatism to become more extreme, and to exceed by far the range of common sense, in the effort to overcome his criticism.'
- 15 Gregory (2013a).
- 16 Gregory (2013b).
- 17 See Gregory (2013).
- 18 Lloyd (1991) p. 423.
- 19 Ibid. p. 422.
- 20 Ibid. p. 423.
- 21 Cf. Graham (2006) p. 14 ff.
- 22 Kahn (1960) p. xi.
- 23 Cornford (1952) p. 198.
- 24 Kahn (1960) p. xii.
- 25 Ibid.: 'That the elements of one or more pre-philosophic views are incorporated in the Ionian cosmology is, I would say, agreed upon by all.'
- 26 See Stobaeus, 1, 29, 1 and Pseudo-Plutarch, III, 3, 1 = Aetius, III, 3, 1 = DK 12A23.
- 27 Hahn (2001) p. 1.
- 28 See, e.g., Dodds (1951), Lloyd (1987). Buxton (1999) is a good collection of papers. I also reject the ideas of a Greek (or Ionian) 'Enlightenment' and of a Greek 'miracle'.
- 29 Cf. Couprie and Kocandrle (2013) p. 88.
- 30 Aristotle, *Physics*, I/4, 187a12.
- 31 Plato, *Phaedo*, 96a8, cf. e.g. Simplicius, *Commentary on Aristotle's Physics*, 154, 17.
- 32 LSJ.
- 33 *phusis* is related to the Greek verb *phuein*, to grow.
- 34 LSJ. *phusis* can mean the 'regular order of nature', especially in the phrase *kata phusin*, 'according to nature'. Aristotle frequently opposes *para phusin* ('contrary to nature') and *kata phusin*.
- 35 See, e.g., Lovejoy (1909), Jaeger (1947) p. 20, Sandbach (1975) p. 31, Curd (1998) pp. 45–7 and especially Naddaf (2005), though also see Naddaf pp. 17 ff. on different readings of *phusis*. Cf. Aristotle, *Metaphysics*, IV, 1015a ff. For some dissenting opinions see Kirk (1954) p. 228 and Mourelatos (1970) pp. 62–3.
- 36 We do find the term *phusin apeiron* used by the commentators, e.g. Simplicius, *Physics* 24, 13, but we do not know if these were Anaximander's own words.

- 37 I take this to be standard among those who study ancient philosophy and science nowadays, though translating *phusis* and cognates as physics or physicists often crops up in web articles or in modern scientific appreciations of the Presocratics. Not even KRS are immune. On p. 385, translating Diogenes Laertius on Archelaus (II, 16) they state: 'It was he who transferred physical philosophy (*phusikên philosophian*) from Ionia to Athens, and he was called a physicist (*phusikos*). Moreover physical philosophy (*phusikê philosophia*) came to an end with him.'
- 38 See Gregory (2013). The key passages here are Diogenes Laertius, IX, 31 where twice there is mention of a membrane, *humena*, in the process of *cosmos* formation. The Greek word here being most typically used of a membrane around the brain, heart or foetus. See also Sextus Empiricus, *Against the Mathematicians*, VII, 116–18, where the analogues for the like-to-like effect are the flocking together of species of birds or the ancient agricultural practice of whirling seeds in a specially designed tray in order to separate them like to like.
- 39 See Couprie and Kocandrlle (2013) pp. 66–7 on 'physicists' and p. 85 on mechanisms, see Drozdek (2008) p. 11 on mechanisms. For a bluntly physical/mechanical view of Anaximander, Sambursky (1956) p. 00: 'It was also Anaximander who used the mechanical model as a means of demonstrating a physical phenomenon.'
- 40 Babut (1972) p. 2.
- 41 See Gregory (2007) Ch. 1. An important example here is that the attribution of soul to the heavenly bodies is done to guarantee their regular motion. Soul allows them to generate their own motion intelligence to choose the right motion every time, see Ch. 2.
- 42 Certainly Anaximander is seen as a part of this tradition by Aristotle, cf. Cicero, *De Divinatione*, I, 50, 112 refers to 'Anaximander, the natural philosopher' while Themistius, *Orations*, 26, 317c tells us that 'Anaximander son of Praxiadēs . . . We believe him to be the first Greek to produce a written account of nature.'
- 43 Where I quote others, I will leave their translation of the Greek *kosmos* unchanged.
- 44 See Burkert (1972) p. 77 note 152
- 45 This is Homer's typical usage, see Kahn (1960) pp. 219–20.
- 46 Kahn (1960) p. 219.
- 47 As Graham (2006) p. 31 note 21 comments on Anaximander and *cosmos*: 'His concept of the world is such that it is adequately described by the term.'
- 48 Mansfeld (2009) p. 14.
- 49 Kahn's translation (1960) p. xxix is 'Physical Opinions', but I am always concerned about translating *phusis* and its cognates as 'physical', as *phusis* has much more of a sense of nature or natural, which can incorporate other ideas of nature than simply 'physical'.
- 50 So McDiarmid (1953) p. 133 comments that: 'With regard to the presocratic causes at least, he is a thoroughly biased witness and even less trustworthy than Aristotle.'

- 51 Theophrastus seems to summarise parts of Plato's *Timaeus* very well, a case where we have the original of what Theophrastus is summarising. Cf. Kahn (1960) p. 21.
- 52 It has also been conjectured that there was an intermediary between the original of Theophrastus and Aetius, working in the Hellenistic period, possibly under the influence of Posidonius.
- 53 Kahn (1960) p. 11. Kahn takes the view that Aristotle and Theophrastus did have access to Anaximander's written work.
- 54 Diogenes Laertius, *Lives of the Philosophers*, 2, 1–2.
- 55 Kirk (1955) p. 37.
- 56 Ibid. pp. 37–8.
- 57 Ibid. p. 38.
- 58 Aristotle, *On the Soul*, I/5, 411a9.
- 59 Or initially transmitted in writing, the writing then lost, then transmitted orally.
- 60 On this see Kahn (1960) pp. 20 ff.
- 61 See Aristotle, *Physics*, I/4, 187a20.
- 62 E.g. Aristotle, *On the Heavens*, 303b9 ff., *Physics*, 203a16 ff. See also the debate about the text/syntax of *Metaphysics*, 1069b19 ff., Drozdek (2012) p. 11, KRS p. 130.
- 63 See Alexander, *Commentary on Aristotle's Metaphysics*, I, 60, 8–10, Simplicius, *Commentary on Aristotle's On the Heavens*, 561, 1–5; 602, 18–23; 615, 11–12, Themistius, *Commentary on Aristotle's Physics*, I, 13, 16–26.
- 64 See Ch. 5 for a fuller discussion here.
- 65 On Heraclitus see KRS p. 184.
- 66 See Kahn (1960) pp. 19–24.
- 67 Ibid. p. 23.
- 68 Blanck (1997). There is a plausible reconstruction of the next line to 'who was a pupil of Thales'.
- 69 Havelock (1983) p. 7.
- 70 Ibid. pp. 7–8.
- 71 Simplicius, *Physics*, 24, 13.
- 72 Kirk (1960) p. 21, cf. McDiarmid (1953).
- 73 See below on ἀποκρίνεσθαι and ἐκκρίνεσθαι, whether the *apeiron* is a mixture or something intermediate between air and fire, air and water or is something separate from the elements, whether unlimited is a substantive or a predicate, whether the *apeiron* is referred to in the singular or the plural.
- 74 On, e.g., whether the *apeiron* is an intermediate element, whether there are multiple co-existent or successive *cosmoi* or a single *cosmos*.
- 75 See Aristotle, *On the Heavens*, I/10, 279b13 ff.
- 76 See here Aristotle, *Metaphysics*, 995a24 ff.
- 77 Kahn (1960) p. 22.
- 78 Ibid. pp. 19–20.
- 79 Kahn (1960) p. 20.

- 80 Kahn (1960) pp. 19–20 argues that ἀποκρίνεσθαι can be found in Homer and Archilochus while ἐκκρίνεσθαι is not found prior to the middle or late fifth century. I do not think that this rules out usage by Anaximander.
- 81 Cf. Theophrastus on mixture. Havelock (1983) p. 43 comments that Theophrastus' material on the Milesians: 'Survives in a context which seems intended to connect them with Anaxagoras as his predecessors or even his philosophical partners.' Simplicius, *Commentary on Aristotle's Physics*, 154, 14 is suggestive here: 'Theophrastus, combining Anaxagoras and Anaximander.'
- 82 Kahn (1960) p. 29.
- 83 Ibid. p. 25.
- 84 Ibid. p. 33.
- 85 Mansfeld (2011) p. 8 comments that: 'Kahn invariably begins his useful collections of quoted passages with the purported Theophrastean evidence and concludes with Aristotle.'
- 86 Engmann (1991) p. 9.
- 87 Finkelberg (1994) p. 496.
- 88 Wöhrle (2012) is now the definitive source on Anaximander.
- 89 I flatly disagree with Havelock (1983) p. 70 that 'no one before Aristotle has ever heard of Anaximander and Anaximenes.'
- 90 Although this view is controversial, I take the *Timaeus* to be at least in part a running commentary on presocratic natural philosophy.
- 91 Or perhaps, to be more precise, Aristotle's version of his views.
- 92 Empedocles, Fr. 17, 26. Cf. Fr. 35, 1–2 'I shall turn back once more to the path of song recounted previously, as I draw off account upon account, in that way', which may be an allusion to Parmenides, Fr. 6 where mortals wander on a backwards turning path, see also Guthrie II pp. 138–9. The opening of Fr. 17 may also recall Parmenides – see here KRS p. 287.
- 93 Xenophanes, Fr. 11, cf. Fr. 12.
- 94 Xenophanes, Fr. 1, 21–23.
- 95 Xenophanes, Fr. 32.
- 96 Lesher (1992) p. 143.
- 97 A good example here would be the treatment of Heraclitus and Protagoras in Plato's *Theaetetus*.
- 98 Burkert (1972).
- 99 Jaeger (1936) p. v.
- 100 von Staden (1992). Cf. Lloyd (1987) and (1992), Rochberg (1992), Pingree (1992), Bernal (1992).
- 101 One might also ask: Are there aspects of Anaximander's thought which have been neglected or minimised by commentators, whatever their views on theology, because in Anaximander's philosophy of nature they saw a likeness between Anaximander and what they think is important in modern theology?

2 Anaximander's Zoogony

- 1 = Aetius, V, 19, 4 = DK12A30.
- 2 E.g. Cornford's (1952) p. 170 speculation that the reference is to sea urchins, or Kleisner and Kocandrle (2012) p. 114, 'The first living creatures may have even been hypothesised to resemble various kinds of shellfish'.
- 3 Barnes (1979) p. 23.
- 4 See, e.g., Loenen (1954) p. 222, 'All organic life originated in the sea' or Cornford (1952) p. 170 and his references to sea urchins; cf. Kleisner and Kocandrle (2012) p. 106.
- 5 This passage is in Pseudo-Plutarch but not Stobaeus.
- 6 KRS p. 141.
- 7 Loenen (1954) p. 225 comments that: 'In A 30 we find the striking and at first sight incomprehensible information that the animals (i.e. the forefathers of the present land-animals, as we have concluded above) were enveloped by a prickly bark, as long as they lived in the water. No doubt is possible as to the authenticity of this testimony. No later writer could possibly have invented such a queer detail'.
- 8 I preserve the comparative ζηρότερον (some translations use dry rather than drier, Graham (2010) has 'moved onto land'), as there is a difference between moving onto the (absolutely) dry and moving onto something relatively drier which may still be significantly moist, such as a submerged stone or log.
- 9 Conche (1991) p. 222, Wöhrle (2012) Ar. 67, p. 59.
- 10 See <http://resources.schoolscience.co.uk/CEH/freshpoll/freshpoll6.html>. These are different types of Caddis fly case rather than a succession of cases.
- 11 Aristotle, *Historia Animalium*, 551b27–552b25, 569b. See also Aristotle, *Generation of Animals*, III/11, 762a18–25: 'Animals and plants are generated in earth and in liquid because there is water in earth, and air in water, and in all air there is vital heat, with the result that there is a sense in which all things are full of soul. So living things quickly form whenever air and vital heat are enclosed in something. When they are enclosed like this, the liquids being heated, then there a frothy bubble comes about'.
- 12 Spontaneous generation, incidentally, is remarkably difficult to disprove. There were considerable experimental difficulties and many failed attempts to disprove it. The experiment that most people will be familiar with, of boiling a beef broth, placing it in a container and then seeing if it went cloudy went through many versions before that familiar from school science textbooks. This experiment was used by both sides of the debate depending on how the experiment was set up and what the results were. The first widespread opposition to spontaneous generation came in seventeenth-century Europe but a conclusive disproof of spontaneous generation was not made until well into the nineteenth century.
- 13 Loenen (1954) p. 227.

- 14 See Loenen (1954) p. 226. My knowledge of them comes from the fact that when I was younger, I went freshwater fishing a lot. A good bait for some freshwater fish is the Caddis fly grub, which you can find in some streams by turning over a few logs or stones. A good bait for fish such as trout or salmon, where you use a different technique called fly fishing, is to dress up a hook to look like an adult Caddis fly, float it on the water's surface and hope the fish take the 'fly'. If the Caddis fly hypothesis is correct, we no longer need to speculate how the creatures within the 'spiny bark' fed themselves.
- 15 Cf. Conche (1991) pp. 222–4 for discussion of translation here.
- 16 Cf. Aristotle, *Historia Animalium*, 558a28.
- 17 Cornford (1952) p. 171.
- 18 Loenen (1954) p. 226 comments: 'In short, what was this bark like and whence did Anaximander get this idea? We do not know.' Hopefully the Caddis fly hypothesis gives us some handle on this.
- 19 Cf. Loenen (1954) p. 219 note 2.
- 20 Kahn (1960) p. 69. Cf. Loenen (1954) pp. 219–20 note 2. Graham (2010) has 'they survived in a different form'.
- 21 Conche (1991) p. 222, Wöhrle (2012) Ar. 67, p. 59, Mansfeld (1983) p. 79. Cf. Erkell (1982) p. 126, 'hätten binnen kurzem ihre Lebensweise verändert'.
- 22 Loenen (1954) gives a good summary of the debate up to that point.
- 23 As Kleisner and Kocandrl (2012) p. 104 put it, 'Usually, it is Empedocles and Lucretius who are seen as the most prominent precursors of evolutionary thinking in ancient philosophy. One can, however, go to even older authors such as Anaximander of Miletus.'
- 24 Gomperz (1911–1912) p. 196.
- 25 Eastman (1905) p. 702, cf. Zeller (1881) I, p. 255: 'The animals, also, he thought, originated from primitive slime, under the influence of the sun's heat; and as the idea of a gradual succession of animal species corresponding with the periods of geological formation was naturally beyond his reach, he assumed that the land animals, including man, had been at first fishes, and afterwards, when they were able to develop themselves under their new shape, had come on shore and thrown off their scales.'
- 26 Burnet (1930) p. 71, Cf. F. de Raedemaker (1953) p. 35. Heath (1913) p. 39 also refers to 'Anaximander's remarkable theory of evolution.'
- 27 I put this as neutrally as possible. Some think there is evidence that the drying out is terminal for the earth/*cosmos* and is part of a successive *cosmoi* theory; I do not.
- 28 See Aristotle, *Meteorologica*, 353b6, Alexander, *Meteorologica*, 67, 11.
- 29 Burnet (1920) p. 71.
- 30 Kahn (1960) p. 113.
- 31 Barnes (1979) p. 22.

- 32 See, e.g., Kahn (1960) p. 70 on sea creatures, or Cornford (1952) p. 171. The assumption is very widespread.
- 33 Loenen (1954) p. 222.
- 34 Ibid. p. 221.
- 35 Conche (1991) p. 222, Wöhrle (2012) Ar. 67, p. 59.
- 36 Kahn (1960) p. 70.
- 37 Aristotle, *Generation of Animals*, III/11, 761b24 ff.
- 38 Kahn (1960) pp. 70–1.
- 39 Cf. Loenen (1954) pp. 220–1.
- 40 E.g. Kahn (1960) p. 109, Guthrie (1965) pp. 90–1, KRS 3 pp. 141–2, Freudenthal (1986) pp. 216–17. Cf. Kleisner and Kocandrle (2012) p. 116, ‘Here we find once again reference to a “prickly bark” that broke on the dry land. We can suppose it had a protective function since it was an organ of creatures living in a moist environment. It could have been seen as analogical to the above-mentioned shells or scales. The breaking of the bark would in a way describe the appearance of life on the dry land.’
- 41 KRS pp. 142 ff.
- 42 Ibid. p. 142.
- 43 Ibid.
- 44 I would agree with Cornford that there is no place for a creator in Anaximander or indeed any of the Milesians: Cornford (1952) p. 170.
- 45 I discuss the Greek here in Ch. 6. I will argue that we have good reason to suppose that these, or something very like them, were Anaximander’s original words.
- 46 Thales: Cicero, *On the Nature of the Gods*, 1, 10, 25, cf. Aristotle, *De Anima*, 405a19, 411a7, Diogenes Laertius, I, 24, Aetius, 1, 7, 11, Stobaeus, 1, 1, 11; Anaximenes: Aetius, I, 3, 4; Heraclitus: Fr. 41 and 64; Parmenides: Fr. 12, ‘Hippocrates’ *On Regimen*, I/10.
- 47 Kirk, p. 35 note 1.
- 48 Ibid.
- 49 Vlastos (1947) pp. 172–3.
- 50 Plato, *Politicus*, 273c2.
- 51 Kirk, p. 35 note 1.
- 52 Plato, *Philebus*, 28d.
- 53 Cf. Drozdek (2008) p. 12.
- 54 Theophrastus, HP 1. 11. 1.
- 55 Barnes (1979) p. 22.
- 56 Ibid. p. 23.
- 57 Homer, *Iliad*, XIV, 246.
- 58 Ibid. XXI, 196.
- 59 Naddaf (2003) p. 17.

3 Anaximander and Meteorology

- 1 Aristotle, *On the Heavens*, II/13, 294a28 ff.: 'Others say the earth rests on water. This is the oldest account we have, given they say by Thales of Miletus, that it remains in place by floating like a piece of wood or something similar (of these things none rest on air, but on water), as if the account concerning the earth did not apply to the water supporting to the earth.' In relation to this Thales explained earthquakes naturally. Seneca, *Natural Questions*, III, 14 tells us that: 'Thales said that the earth is held up by water and rides on it in the manner of a ship. When it is said to quake it is rocking due to the motion of the water.' Similarly, Pseudo-Plutarch, III, 15 says that: 'Thales and Democritus attribute the cause of earthquakes to water.'
- 2 See Aristotle, *Meteorology*, I/1.
- 3 See also Taub (2003). Aristotle also includes some astronomical phenomena which he believes occur in the upper reaches of the terrestrial realm, comets, shooting stars, etc.
- 4 See Gregory (2013).
- 5 Stobaeus, 1, 29, 1.
- 6 Pseudo-Plutarch, III, 3, 1 = Aetius, III, 3, 1 = DK12A23.
- 7 Wöhrle (2012) prints both, Ar. 63 and Ar. 148.
- 8 Vlastos (1952) cites Gilbert (1895) p. 292 notes 3 and 5.
- 9 Vlastos (1952) p. 97. Vlastos cites Thucydides, 7.50.4.
- 10 Lloyd (1970) p. 9.
- 11 Cf. Lloyd (1991) p. 420: all we have is a natural explanation, is a rejection of non-natural explanation merely our conjecture?
- 12 Xenophanes, Fr. 32.
- 13 I would agree that we should not assume that 'every time some Greek before Xenophanes saw a rainbow they automatically thought of it as a portent', but clearly some Presocratics, and in Homer and Hesiod some highly influential Presocratics, did see the rainbow as a portent.
- 14 Lloyd (1991) p. 420. Cf. Vlastos (1975) p. xii, a strong supporter of the rejection of the supernatural view, who asked, 'What were they fighting against, and what were they fighting for?', answering that they fought against the supernatural and for the notion of *cosmos*.
- 15 Lloyd (1991) p. 420.
- 16 Xenophanes, Fr. 11, cf. Fr. 12.
- 17 Xenophanes, Fr. 1, 21-23. See Ch. 1 and Gregory (2013).
- 18 It had been thought to be Roman, but new material has come to light. See Mourelatos (2008) pp. 135 and 160 notes 12 and 13.
- 19 Dodds (1951) pp. 180-1.
- 20 Cicero, *On Divination*, I/5.

- 21 Lloyd is rather scathing about the quality of Xenophanes' theory of the rainbow as a cloud. He says: 'Now that does not seem a particularly inspired suggestion, even if we make allowances for Xenophanes as a very early debutant natural scientist: it is not even as if a rainbow reasonably obviously resembles a cloud.' Mourelatos has suggested that *iris* here refers to a broader range of phenomena than just rainbows, such as halos, caronae, parhelia and cloud iridescence. This is helpful in several ways. An *iris* can then precede a storm, unlike rainbows, which usually follow a storm. It is more plausible to think of a rainbow as a cloud if it is a type of *iris* and all types are clouds. This makes the 'rainbow' theory considerably more powerful if it is taking in all of the *iris* phenomena here.
- 22 Homer, *Iliad*, VIII/133, XXI/198, *Odyssey*, XXIV/539.
- 23 Ibid. IX/236.
- 24 Homer, *Odyssey*, V/128, VII/249, XII/415, XIV/305, XXIII/330.
- 25 Hesiod, *Theogony*, 139 ff.
- 26 Ibid. 689 ff.
- 27 See Hesiod, *Theogony*, 72, 286, 503, 707, 854.
- 28 Ibid. 845–6.
- 29 Ibid. 307.
- 30 Ibid. 689 ff.
- 31 Hesiod, *Works and Days*, 53 for Zeus as cloud-gatherer and *Works and Days*, 416 for Zeus as rain bringer.
- 32 See, e.g., Homer, *Iliad*, XII/25 ff. where he rains continually to submerge a strategically important wall, Homer, *Iliad*, XI/385 ff. to punish unjust men.
- 33 See, e.g., Homer, *Iliad*, XV/3789 ff. to aid the Achaeans in battle, Homer, *Iliad*, XI/385 ff. to punish unjust men, Homer, *Odyssey*, IX/67 ff. one of many storms at sea.
- 34 For winds in Hesiod, see *Theogony*, 253, 706 and the battle between Zeus and the Titans beginning at 821 and especially the comments on Typhoeus at 869. For winds in Homer, see, e.g. the first part of Homer, *Odyssey*, X.
- 35 Greene (1992) pp. 46 ff.
- 36 Theophrastus also gives a long list of meteorological phenomena and explanations, unfortunately without names! He too treats all five of the Anaximander phenomena if we take winds in general as a substitute for Typhoons, four if we do not. Seneca deals extensively with meteorological issues in *Natural Questions*.
- 37 Aristotle, *Meteorologica*, 369a10, II/9.
- 38 Ibid. 359b27 ff.
- 39 Ibid. 365b22 ff.
- 40 It is also worth noting in relation to the chronology here that Epicurus deals with these four phenomena plus winds in a close sequence (Epicurus, *Letter to Pythocles*, 101–5), as does Lucretius, who opens book six of *On the Nature of Things* with a set of natural explanations of meteorological phenomena.

- 41 See Gregory (2013a). This list is not meant to be exhaustive but does contain the key examples from that book.
- 42 See Gregory (2013a) Ch. 1 and Ch. 3.
- 43 Kahn (1960) p. 99 ff. finds little development in Greek meteorology once Anaximander gives naturalistic explanations, Taub (2003) p. 10 finds rather more. I tend to side with Taub, though I would locate the development to producing explanations of more meteorological phenomena (rainbows, St Elmo's fire, etc.) and to giving more detailed explanations consistent with the philosophical developments.
- 44 Pseudo-Plutarch, 5, 1, 1: 'Xenophanes and Epicurus did away completely with divination.'
- 45 See Gregory (2013a) Ch. 6.
- 46 Ibid. Ch. 4 and Ch. 5.
- 47 Ibid. Ch. 6.
- 48 Ibid. Ch. 10.
- 49 Empedocles is an interesting case as he too clearly alludes to Homer and Hesiod, but seems to do so for different reasons, often emphasising that humans can do, or aspire to do, what in Homer and Hesiod is reserved for the gods.
- 50 Heraclitus, Fr. 64.
- 51 Seneca, *Natural Questions*, II/18.
- 52 Hippolytus, *The Refutation of All Heresies*, I, 6, 7.
- 53 Pseudo-Plutarch, III, 7.
- 54 Shelley (2000).
- 55 Ibid. pp. 5–6. Cf. p. 2: 'None of these scholars consider alternative possible sources of Anaximander's meteorological ideas, so that support for mythology as the source derives largely from the lack of a rival. But there is an alternative, namely, folk meteorology.'
- 56 Cicero, *De Divinatione*, I, 50, 112.
- 57 West (1971b) p. 97.
- 58 Ibid. West references Hesiod, *Theogony*, 706 ff. and *Works and Days*, 548 ff. in his notes, as well as Kahn (1960) pp. 145 ff.
- 59 See, e.g., Hesiod, *Works and Days*, 53, 416, *Theogony*, 253, 706, 821 ff. and esp. 869, Homer, *Iliad*, XI/385 ff., XII/25 ff., *Iliad*, XV/3789 ff., *Odyssey*, IX/67 ff.
- 60 West (1971b) p. 97.
- 61 Ibid. p. 99.
- 62 Lloyd (1991) p. 422.
- 63 Lloyd's (1991) p. 423 counter to this is that how natural explanations should be pursued was not in the least part clear and was contested, both in terms of content and methodology.
- 64 Lloyd has pointed out that they would be aware of natural regularities, which is undoubtedly true, but there is a significant difference between being aware of some

regularities and proper invariance, especially as it would seem that in some cases the gods of Homer and Hesiod have the power to override those regularities, e.g. the case of sea winds in Hesiod.

65 Pseudo-Plutarch, III, 7.

66 Hippolytus, *The Refutation of All Heresies*, I, 6, 7.

67 Cornford (1952) p. 198.

4 The Extant Fragment

1 Simplicius, *Physics*, 24, 13.

2 See KRS pp. 105 f., 117 ff. This is also disputed, especially the words preceding κατὰ τὸ χρεὼν – see below. Mansfeld (1983) takes the whole first sentence from ἐξ ὧν as part of the fragment.

3 Wöhrle (2012) Ar. 163, p. 131. Wöhrle's text is the same.

4 Though as Mansfeld (2011) p. 15 has suggested, it can also mean death.

5 Mourelatos (1970) pp. 277 ff.

6 Rivaud (1906) p. 93, Conche (1991) p. 157.

7 Kahn (1960) p. 180, 'gemäß der zeitlichen Ordnung', Mansfeld (1983) p. 73.

8 Here I would wholeheartedly agree with Mansfeld (2009) p. 11 on why the *allêlois* reading is accepted: 'The gradual replacement of the mystical reading by naturalistic ways of interpretation mirrors the growing secularization of the West, which makes itself felt even in this remote corner of the intellectual world. In its modest way the history of the reception of Anaximander is a part of cultural history, or history of mentalities. But secularization is not the cause of this change of direction, though it certainly favoured it, and continues favouring it. Its main incentive is philological, and has to do with the *constitution* of the text of the fragment, viz. the presence of the word *allêlois*, and the scope of the terms "injustice" and "retribution".

9 Cf. Mansfeld (2009) p. 11.

10 Kahn (1960) p. 167, cf. Graham (2006) 34 ff.

11 Vlastos (1947) p. 172.

12 KRS p. 120.

13 Solon lived in the late seventh and early sixth centuries BCE and was an Athenian statesman and poet, who introduced important economic and moral reforms aimed at preventing a perceived decline in the political and social life of Athens.

14 KRS translation, KRS p. 121.

15 For criticism of this view see Havelock (1978) p. 264.

16 Conche (1991) p. 157.

17 Vlastos (1947) p. 170.

18 Cherniss (1935) pp. 376–7.

- 19 Vlastos (1947) p. 171.
- 20 McDiarmid (1953) p. 141 note 57.
- 21 Graham (2006) p. 38.
- 22 Translation: W.R.M. Lamb. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd 1925.
- 23 Wöhrle (2012) p. 238.
- 24 KRS p. 106, cf. Finkelberg (1993) p. 229.
- 25 If we want a more sophisticated account, then we can also bring in the dry/wet pair on contraries, so it is hot, dry summer now, etc.
- 26 There is a possible modern and certainly anachronistic interpretation of 'according to the ordering of time', which would be to relate it to the second law of thermodynamics. In short, there is a tendency for temperature differences to even out over time such that the end state for the universe would be that of 'heat death', where there is a uniform (and very low) temperature throughout the universe. So the injustices of a differential distribution of hot and cold (or other qualities) throughout the *cosmos* would gradually be righted by time and would result in the dissolution of the *cosmos*, at least in the sense of the *cosmos* being a well-ordered entity. This ascribes far too many modern notions to Anaximander though and also ignores any action of the steering principle which might counteract the tendency of the second law of thermodynamics.
- 27 Plato, *Timaeus*, 39c, 'The wanderings of these stars constitute time'. Cf. *Timaeus*, 37d where the demiurge 'Intended to create a movable image of eternity, and at the same time as ordering the heavens, he made from the eternity that resides in unity an eternal image moving according to number, that which we have called time' and *Timaeus*, 38c: 'From this reasoning and thought by God concerning the generation of time, in order that time should come to be, the sun and the moon and the five other stars, which have the name "wanderers", came into being to determine and guard the numbers of time.'
- 28 Graham (2006) p. 35.
- 29 Anaximenes believed that the sun governed the seasons, DK13A14.
- 30 Alexander Polyhistor, from Diogenes Laertius, 50, 8, 24.
- 31 Cornford (1952) p. 168 ff.
- 32 Empedocles, Fr. 17, 27 ff., trans. Cornford (1952) p. 168.
- 33 Engmann (1991) p. 20.
- 34 See Aristotle, *Physics*, I/4, 187a20 ff., Pseudo-Plutarch, *Stromateis*, 2, Kahn (1960) pp. 39–42.
- 35 Vlastos (1947) p. 174.
- 36 KRS pp. 120–1.
- 37 Theognis lived in the sixth century BCE and is one of the earliest poets whose work survives in any substantial quantity. One of his topics was anxiety over the current

political situation, he was also a moraliser. He was concerned with the possible deterioration of the city, so: 'Wealth has mixed up blood. And so, Polypaides, do not be surprised that the townsman's stock is becoming enfeebled, since what is noble is mixing with what is base.' Theognis, 190–2, Gerber's translation.

38 Theognis, 677–8, trans. Vlastos.

39 See Seaford (2004) p. 194.

40 Graham (2006) p. 36.

41 Heraclitus, Fr. 80, agreeing with the usual emendation of $\chi\rho\epsilon\acute{\omega}\nu$ for $\chi\rho\acute{\omega}\mu\epsilon\nu\alpha$, see KRS p. 193.

42 KRS p. 194.

43 See here KRS p. 194 and Vlastos (1955) p. 356 for a slightly different view on this.

44 Mansfeld (2011) p. 12

45 Gagarin (2002) p. 22.

46 Heraclitus, Fr. 90.

47 Freudenthal (1986) p. 198, Vlastos (1947).

48 Freudenthal (1986) p. 208.

49 Vlastos (1947) p. 173.

50 Cf. Drozdek (2008) pp. 10–11.

51 Vlastos (1947) p. 173.

52 Freudenthal (1986) p. 197. Cf. Freudenthal (1986) p. 227: 'To take cognizance of order, to account for the world's being *cosmos* and not chaos, the theory of the opposites had to be backed up by metaphysics.'

53 So the *apeiron* and the steering principle are both natural in the sense of being part of *phusis* and behaving in an invariant manner. See Gregory (2013a) Ch. 1 for discussion and definitions of natural/supernatural and what is and is not part of *phusis* for the ancients.

54 Freudenthal (1986) p. 227.

55 Hesiod, *Theogony*, 74–5, trans. West.

56 Hesiod, *Works and Days*, 277, trans. West.

57 West (1971b) p. 77.

5 The *Apeiron*

1 Cf. Finkelberg (1993) p. 229, Graham (2010) p. 45.

2 If 'bound' is preferred for *peirar*, *peras*, then boundless or unbounded for *apeiron*. I take these to be equivalent to 'unlimited'.

3 Kahn (1960) p. 232.

4 Ibid. p. 231.

5 Ibid. p. 232. Cf. Conche (1991) pp. 70 ff.

- 6 Ibid. p. 232.
- 7 Tannery (1904) p. 704, Tumarkin (1943) pp. 56–7.
- 8 Semerano (2001) p. 32.
- 9 Cf. Couprie and Kocandrlle (2013) p. 4. Semerano (2001) cites Genesis 3:19 on coming from and ending in dust as a parallel.
- 10 Graham (2006) pp. 29–30.
- 11 See Kahn (1960) pp. 231 ff., Gottschalk (1965) pp. 51–2, Dancy (1989) pp. 170 ff., Graham (2006) p. 30.
- 12 ἀόριστος would be fairly standard for indeterminate.
- 13 Cf. Graham (2006) p. 32.
- 14 Kahn (1960) p. 233.
- 15 See, e.g., Xenophanes, DK21B28, Zeno, DK29B1, Anaxagoras, DK59B2.
- 16 Kahn (1960) p. 233.
- 17 Ibid.
- 18 Couprie and Kocandrlle (2013) p. 65.
- 19 Alexander, *Commentary on Aristotle's Metaphysics*, 47, 19 ff., Simplicius, *Commentary on Aristotle's Physics*, 458, 19 ff.
- 20 Alexander attributes an intermediate substance to Anaximander. In my view he is incorrect to attribute a terminally drying earth either to Anaximander or to Diogenes. Cf. Conche (1991) p. 91, who argues this passage does not refer to Anaximander.
- 21 See, e.g., Simplicius, *Commentary on Aristotle's Physics*, 24, 13 ff., Hippolytus, *Refutation of All Heresies*, I, 6, 1–2.
- 22 Couprie and Kocandrlle (2013) pp. 82 ff.
- 23 Ibid. p. 83.
- 24 Ibid. p. 72.
- 25 This will depend on how far we follow Couprie and Kocandrlle (2013) p. 69 in reading to *apeiron* as 'that what is called boundless'.
- 26 See Aristotle, *Physics*, 189b3, *On the Heavens*, 303b11, *On Coming to be and Passing Away*, 328b35, *Metaphysics*, 988a30 and cf. *Physics*, III/4, 203a16–18. It is possible (just) to argue that Aristotle is neither confused nor attributes an intermediate to Anaximander, but this means taking some passages which seem quite clearly to refer to Anaximander as not referring to him in an arbitrary manner. As indicated in the first chapter, I am inclined to allow Aristotle some understandable confusion on an oral source he finds difficult to fit into Aristotelian schema. Certainly the later doxography attributes an intermediate substance to Anaximander.
- 27 Aristotle, *Physics*, I/4, 187a20 ff.
- 28 See Aristotle, *Physics*, III/5, 204b22–35, *On Generation and Corruption*, II/1, 329a5–15 and 332a18–26.
- 29 See here Aetius, I, 3,3, Simplicius, *Commentary on Aristotle's Physics*, Diogenes, *Laertius Lives*, II, 1.

- 30 Couprie and Kocandrlje (2013) pp. 65–6.
- 31 Ibid. p. 88.
- 32 Heath (1913) pp. 28–9.
- 33 Cf. Rescher (2005) p. 4.
- 34 Aristotle, *On the Heavens*, I/7, 275b14, μέσον μὲν γὰρ τοῦ ἀπείρου οὐκ ἔστι, there is no centre to the infinite, cf. 276a8 ff. See also, albeit later, Lucretius, 62e12 ff.
- 35 See Ch. 8 for a full discussion of this view.
- 36 Plato, *Philebus*, 17e5, cf. *Philebus*, 64e and *Theaetetus*, 183b and *Timaeus*, 55c: ‘If in considering all this someone should raise the quite proper question of whether the number of *cosmoi* should be said to be unlimited or limited, he will suppose that the view that they are infinite is that of someone who is indefinite (*apeirou*) on a matter on which he should be definite.’
- 37 Seligman (1962) p. 125. Seligman is criticising the view of Cornford (1952) p. 34.
- 38 Cf. Conche (1991) p. 127, Ch. 6 title ‘Les Raisons D’Admettre L’infini’.
- 39 Cf. Cornford (1952) pp. 178–9.
- 40 See Gregory (2007) Ch. 13.
- 41 Here I would agree with Kirk (KRS p. 110) who comments that ‘we may legitimately doubt whether the concept of infinity was apprehended before questions of continuous extension and continuous divisibility were raised by Melissus and Zeno’.
- 42 Drozdek (2008) p. 9, cf. pp. 16–17.
- 43 Kahn (1960) p. 232, Cornford (1952) p. 176 ff.
- 44 See Cornford (1952) pp. 176–7.
- 45 Seaford (2012) p. 60.
- 46 Ibid. p. 59.
- 47 See here Mansfeld (2011) p. 13.
- 48 See Aristotle, *On the Heavens*, I/9, 297a23–8, cf. *Physics*, IV/2, 218a11–14 and IV/12, 228a28–9.
- 49 Mansfeld (2011) p. 13.
- 50 Aristotle, *Physics*, III/4, 203b7 ff.
- 51 This point is missed in an alarmingly large number of discussions of this passage.
- 52 Cf. Matson (1953) p. 392.
- 53 There is some evidence that Anaximander believed in a multiplicity of gods, though I very much doubt if any of this evidence is reliable. Babut (1972) comments ‘on ne peut accorder foi aux témoignages d’Aétius et Cicéron selon lesquels Anaximandre aurait admis l’existence d’une pluralité indéfinie de dieux engenders’. There are three passages here: Stobaeus, I, 1, 29, ‘Anaximander said that the unlimited heavens were gods’, Pseudo-Plutarch, I, 7, 12 (=Aetius, I, 7, 12), ‘For Anaximander the stars were heavenly gods’, Cicero, *On the Nature of the Gods*, I, 10, 25, ‘In Anaximander’s opinion, there are gods who are born and who perish after long intervals, and these are the

innumerable worlds. But how is it possible to understand anything to be a god which is not eternal?' There is no consensus here on what is a god. Two of these passages rely on a multiple co-existent cosmoi view which is inappropriate for Anaximander. I place very little reliance on any of these passages.

54 Jaeger (1947) p. 36.

55 See Lloyd (1991) p. 419.

56 Martin (2004) p. 15.

57 See, e.g., Gregory (2007) Ch. 2, Sedley (2007) Ch. 1.

58 Vlastos (1952) p. 119. Cf. Lloyd (1979) p. 11, Jaeger (1947), Hussey (1972), Trepanier (2010).

59 See Spinoza (1677).

60 Toland (1705) *Socinianism Truly Stated, by a Pantheist*.

61 Raphson (1697) *De Spatio Reali*.

62 Aristotle, *On Animals*, I/2, 405a19.

63 Ibid. 411a7, cf. Contra KRS p. 95, amber when rubbed produces static electricity, not a magnetic field. The earliest differentiation between electrostatic and magnetic effects though was not until the sixteenth century, with William Gilbert's *De Magnete*.

64 Plato, *Philebus*, 28d

65 See Stobaeus, I, 10, 12. Cf. Pseudo-Plutarch, I, 3, 4, Stobaeus, I, 1, 29b, Cicero, *De Natura Deorum*, I, 10, 26.

66 Dawkins (2007) p. 40.

67 Xenophanes, Fr. 11, cf. Fr. 12.

68 Burnet (1930) p. 13

69 Matson (1953).

70 Jaeger (1947) p. 36.

71 Burch (1949–1950).

72 Jaeger (1980) pp. 204 ff. The predicates that Jaeger refers to are ungenerated, incorruptible, undying, indestructible.

73 Draper (1874) and White (1896) are the classic statements of the conflict thesis. See Brooke (1991) and Dixon (2008) for comment and the new complexity theory. Babut (1972) is considered the best piece on the divine in Anaximander, but even he speaks of 'Le conflit entre l'explication rationnelle des phénomènes, tentée par la science ionienne.' (p. 2).

74 See Brooke (1991), Dixon (2008).

75 One might compare recent moves by Empedocles scholars, dealing with fragments which have been rather arbitrarily sorted into a 'scientific' poem and a 'religious' poem. There is very little evidence in the ancient world that Empedocles wrote two poems or that they were divided along these lines.

76 Drozdek (2008) p. 11.

- 77 Seligman (1962) p. 60 is a good example of the contrary view: 'Anaximander's doctrines constitute a cosmological rather than a theological view.'
- 78 Babut (1972) p. 22. Cf. p. 1, 'Face à la religion populaire, son attitude est plutôt celle du détachement et de l'objectivité.'

6 Cosmogony and Steering

- 1 Aristotle, *Physics*, I/4, 187a20, DK12A9.
- 2 See Aristotle, *History of Animals*, 578a11, 572b22.
- 3 See Aristotle, *Generation of Animals*, 765b10.
- 4 Pseudo-Plutarch, *Stromateis*, 2.
- 5 See KRS p. 131.
- 6 Cornford (1965) p. 163.
- 7 Damascius, *De Principiis*, 123 (DK1B12) gives Chronos, Aether and Chaos as the usual precursors; later on he gives a more exotic version.
- 8 Vlastos (1947) p. 171 note 140.
- 9 Ibid. p. 173.
- 10 Stokes (1963) p. 11 note 1.
- 11 Simplicius, *Physics*, 327, 24. See also Simplicius, *Physics*, 327, 330, 14, Themistius, *Physics*, 49, 13, Cicero, *De Natura Deorum*, I, 24, 66.
- 12 This is Kahn's (1960) p. 44 view as well. He also cites the frequency of use in other early sources.
- 13 Conche (1991) p. 58, 'embrasser toutes et toutes les gouverner', Mansfeld (1983) p. 73, 'alles zu umfassen und alles zu steuern', though Wöhrle (2012) Ar. 2, p. 15 is less clear: 'Darum sei, wie schon eben gesagt, ein Prinzip für dieses Prinzip undenkbar; vielmehr möchte man meinen, daß umgekehrt dieses das Prinzip alles Konkreten darstelle, all das Konkrete in sich beschließe und es beherrsche, was ja auch wirklich die Meinung aller derer ist, die neben das Unendliche kein weiteres Prinzip mehr stellen wollen – Weltvernunft, Liebe oder dergleichen –. Und so gilt es denn dann auch als das Göttliche.'
- 14 Babut (1972) p. 6.
- 15 Terpander lived in the first half of the seventh century BCE and was important in the development of Greek music and lyric poetry. No poems survive complete and relatively little of his work is quoted by later writers and so known to us. It is doubtful whether Terpander wrote anything; what we have may well have initially been transmitted by an oral tradition.
- 16 Guthrie, I, p. 88 note 2, cf. LSJ give 'steer', 'drive', 'guide, govern', 'act as pilot'.
- 17 Plato, *Politicus*, 272d.
- 18 Ibid. 273b ff.

- 19 Furley (1987) pp. 23–4. Cf. Graham (2006) p. 43.
- 20 Plato, *Philebus*, 28d.
- 21 Ibid. at 30d.
- 22 See Aristotle, *Metaphysics*, I/3, 984a19 ff.
- 23 Plato, *Philebus*, 28d.
- 24 Heraclitus, Fr. 41.
- 25 Ibid. at Fr. 64.
- 26 One might say such an example then contradicts what I have just said about steering and cosmogony. There are two replies here. First, I just want to establish that some ancients used steering in relation to cosmogony. Second, steering may well have an important ongoing ordering role in Heraclitus. If his *cosmos* would fall apart like the *kukeon* drink unless stirred (Fr. 125), the steering may guide the processes which keep the *cosmos* ordered.
- 27 Taking *ton auton hapantôn* as genuine with Guthrie, Vlastos and Kahn but against Kirk and KRS.
- 28 Heraclitus, Fr. 30.
- 29 *diacosmeo* is interestingly strong, suggesting a thorough ordering. LSJ give to divide and marshal, muster, array with usages drawn from Homer and Thucydides. In Thucydides, *διάκοσμος* means 'battle-formation'. Cf. Mourelatos (1970) p. 230 on a similar use in Parmenides.
- 30 Hippocratic author, *On Regimen*, I/10.
- 31 So we might also consider bringing the Derveni Papyrus within this tradition, as Column 19 says: 'Existing things have each been called a single name on account of what dominates (*epikratountos*) them, all things being called Zeus for this reason. Air dominates (*epikratei*) all as far as it wants to.'
- 32 Diogenes of Apollonia, Fr. 5.
- 33 Parmenides, Fr. 12.
- 34 See Gregory (2007) Ch. 2; in relation to Anaximenes, see Stobaeus, I, 10, 12 (=Aetius I, 3, 4, DK13B2), cf. Pseudo-Plutarch, I, 3, 4, Diogenes of Apollonia, Fr. 5 and Derveni Papyrus Col. 19.
- 35 Plato, *Philebus*, 28d.
- 36 Pseudo-Plutarch, II, 15, 6 (=Aetius II, 15, 6).
- 37 Aristotle, *On the Heavens*, II/13, 295a7 ff.
- 38 Ibid. at 295b10 ff.
- 39 Ibid. at 294a28 ff.
- 40 Ibid. Book IV.
- 41 I have argued elsewhere (Gregory (2007) Ch. 2) that Thales did not believe in vortices. West (1963) pp. 172 ff., cf. (1971b) pp. 212–13 gives the case that he did.
- 42 See Chapter 8 for further discussion.
- 43 West (1963) p. 173.

- 44 Simplicius, *Commentary on Aristotle's Physics*, 1121, 5
- 45 Cf. Hermias, *Irrisio gentilium philosophorum*, 10: 'A fellow citizen of his (Thales), Anaximander said that the eternal motion is an older *archê* than moisture and that through things are generated and things are destroyed.'
- 46 West (1963) p. 174.
- 47 Vlastos (1947) p. 168.
- 48 Conche (1991) pp. 139 ff.
- 49 Generally it is held that cosmogony became a science around 1920–1930, when the first calculations were made on the age of the universe using Hubble's data on the recession rates of stars. Using Hubble's law, $v = Hr$ (recession velocity equals distance times Hubble's constant), it is possible to calculate an age for the universe.
- 50 Gregory (2007) Ch. 1.
- 51 See here, e.g., Frankfort (1946), Vernant (1965).
- 52 Alkman (c. 600 BC) is another possible bridge between myth and philosophy, but it is clear he has multiple divinities, and what little we know of him is badly corrupted by later commentators. See Penwill (1974), West (1963) pp. 154 ff., West (1967), Vernant (1970), West (1971b) pp. 206–8, KRS pp. 47–9.
- 53 See Aristotle, *Metaphysics*, 1091b.
- 54 One issue here is how to translate the Greek word *chaos*, which I have rendered here as chasm. *Chaos* does not mean chaos in the modern sense, nor does it mean void in any sense where the void would be unlimited. It can mean the space between earth and sky, and it can mean a gaping or yawning chasm, where the chasm is a limited space. So the first event in cosmogony here could be the separation of the earth and sky generating the space between, or the generation of a limited chasm. See the discussion of KRS p. 37 ff. For the separation of earth and sky in later Greek literature, see KRS pp. 42–3, and in non-Greek sources see pp. 43–4.
- 55 I follow KRS here in omitting line 118, which is in some medieval MSS but not in many ancient quotations. See KRS p. 35 note 1.
- 56 Hesiod, *Theogony*, 116–33.
- 57 Hesiod, *Works and Days*, 303 ff.
- 58 Anaximander, Fr. 2.
- 59 Hesiod, *Works and Days*, p. 50 ff.
- 60 Ibid. at 81 ff.
- 61 It may be the case that Hesiod produces no new gods (i.e. gods who were not present in previous mythologies) and attempts to systematise these, but he still uses far more gods than a parsimonious account of cosmogony would require.
- 62 For example, Earth bears Pontos parthenogenetically (132), Night bears doom, fate, death, sleep, dreams and misery (213 ff.).
- 63 Mansfeld (2011) p. 12.
- 64 KRS p. 142.

7 Anaximander: One *Cosmos* or Many?

- 1 By the time of the doxographers, who use *apeiros* in this context, *apeiros* does have the sense of infinite/unlimited as it would with the atomists. Aristotle and Theophrastus do not use *apeiros* in this context, which may be significant, see below. I use the modern term 'multiple' as a synonym for infinite.
- 2 Zeller (1931).
- 3 Burnet (1920) p. 50 ff.
- 4 Cornford (1934).
- 5 Kirk (1955) and KRS p. 122 ff., Kahn (1960).
- 6 West (1971b) pp. 80–1, Conche (1991) pp. 100–26, McKirahan (2001).
- 7 Finkelberg (1994).
- 8 Neither Finkelberg (1994) nor McKirahan (2001) mention steering at all.
- 9 McKirahan (2001).
- 10 Ibid. at p. 59.
- 11 Kirk (1955) p. 29.
- 12 McKirahan (2001) p. 59.
- 13 Cornford (1934) p. 15
- 14 KRS p. 122.
- 15 McKirahan (2001) p. 59, the quotation is KRS p. 110.
- 16 Our own universe is unlimited but finite and has changed in size from vanishingly small to extremely large.
- 17 McKirahan (2001) p. 60.
- 18 Ibid.
- 19 With some qualifications, I take a literal view of cosmogony in Plato rather than a metaphorical view. See Gregory (2007) Ch. 9 and (2009).
- 20 Plato, *Timaeus*, 30a.
- 21 Ibid. at 41a, cf. *Timaeus*, 32c, 38b.
- 22 McKirahan (2001) p. 60.
- 23 Ibid.
- 24 One might be concerned that a cosmic intelligence could produce many *cosmoi*. I would turn that around, and simply ask why would it? Especially if the first one is made as well as a *cosmos* can be made?
- 25 See here Gregory (2007) Ch. 5.
- 26 Ibid. at Ch. 9.
- 27 McKirahan (2001) p. 61.
- 28 Metrodorus of Chios, KRS translation.
- 29 Gregory, Leucippus and Democritus on Like to Like and *ou mallon, forthcoming, Apeiron*.
- 30 Cf. Barnes (1982) p. 553 ff.

- 31 Simplicius, *Physics*, 28, 8. Cf. Aristotle, *Physics*, III/4, 203b25, Epicurus, *Letter to Herodotus*, 42, 5–12: ‘In addition to this, the full atomic bodies, out of which all compounds are generated and into which they are all dissolved, have an incomprehensible variety of shapes. It is not possible for such much variety in things to have come about from a comprehensible number of the same shapes. For each shape, there is an absolute infinity of like atoms, but the varieties of shape are only incomprehensible in number, not absolutely infinite.’
- 32 Cf. Epicurus and Lucretius, *On the Nature of Things*, II, 216–25: ‘When bodies fall through the void due to their weight, at quite uncertain times and places they swerve a little from their course, just enough for this to be called a change of motion. If they were not accustomed to swerving, they would all fall down, like drops of rain through the deep void, and there would be neither collisions nor blows between the primary bodies. Thus nature could never have produced anything.’
- 33 I cannot go into the full ramifications of the argument here, but I will try to forestall one objection. One might argue that all the motions of the atoms in the void are necessitated and so *cosmos* formation is necessitated by the distribution of atoms and their velocities in void. However, that distribution I argue is *ou mallon*, there is no initial distribution and so *cosmos* formation is *ou mallon* as well. Cf. Epicurus, *Letter to Pythocles*, 89, 6–11: ‘Cosmos formation occurs when the appropriate seeds flow in from one cosmos or an intercosmos or from many. Gradually, by additions and joinings and migrations to another place, as may occur, and appropriate irrigations of this matter, a state of completion and permanence is reached, which lasts while the underlying foundations are capable of being added to.’
- 34 This is not to say that Leucippus and Democritus relied entirely on mechanical analogies, just that, in this respect, there is a mechanical aspect to *cosmos* generation. In other contexts I would argue that they relied on biological and agricultural analogies.
- 35 See Aristotle, *De Caelo*, II/13, 295b10 ff., cf. Plato, *Phaedo*, 108e, Hippolytus, *Refutation of All Heresies*, I, 6, 3. See next chapter for further discussion.
- 36 Eusebius, P.E. XIV, 22, 3.
- 37 Stobaeus, I, 22, 3 (=Aetius II, 1, 8).
- 38 The issue for Newton and Einstein, expressed in slightly different ways, was the inevitable collapse of the universe if it was static and contained gravitating matter. If there was knife-edge stability, that collapse could have no preferred direction.
- 39 So a diametrically opposed pair at equal distances from the earth perish at the same time. There could also be more complex arrangements than this.
- 40 Finkelberg (1994) p. 498.
- 41 See *Meteorology*, I/14, 352a ff.
- 42 Cornford (1952) pp. 183–5, Kahn (1960) p. 185, KRS p. 139.
- 43 Mansfeld (2009) p. 29.

- 44 Anaximander makes great use of wind in explanation, cf. Aetius, III, 3, 1 and Seneca, *Natural Questions*, II, 18.
- 45 See Xenophanes, Fr. 30, 46. See also Aristotle, *On Generation and Corruption*, 336b ff.
- 46 Heraclitus, Fr. 125.
- 47 Barley meal, grated cheese and wine, Homer, *Illiad*, XI, 638 ff., with honey as well, Homer, *Odyssey*, X, 234.
- 48 Apollonius of Rhodes, iv, 269 scholium.
- 49 Finkelberg (1994) p. 499.
- 50 See below for my historiographical disagreement with Finkelberg on Theophrastus' evidence.
- 51 See, e.g., Vlastos (1947) p. 76, Freudenthal (1986) pp. 197, 218.
- 52 I would also note that terminal drying out on its own does not give successive *cosmoi*, only the end of this one.
- 53 Kirk (1955) p. 29, Kirk's italics.
- 54 Lucretius, *De Rerum Natura*, 5, 186–94. A classic passage in opposition to this is Cicero, *On the Nature of the Gods*, II, XXXVII: 'Should I not be amazed here that anyone might persuade themselves that certain solid and indivisible pieces of matter are carried by their own weight and from the fortunate combination of these bodies a world of the greatest splendour and beauty is generated? I fail to see why someone who thinks this can occur does not also believe that if innumerable copies of the twenty one letters, made of gold or anything else, were thrown together in some vessel then shaken out onto the ground, it is possible that they would form a readable Annals of Ennius. I doubt whether fortune would give us even a single verse!' Cf. Plato, *Laws*, 889b, a much underrated passage with some interesting and subtle critiques of the early atomists.
- 55 Kirk (1955) p. 29, Kirk's italics.
- 56 Gregory (2007).
- 57 *Cosmoi* are surrounded by a membrane which marks the boundaries of that *cosmos* and individuates *cosmoi*, see Diogenes Laertius, IX, 31 and Aetius, II, 7, 2. Note also that the first phase of cosmogony then is the 'cutting off from the infinite' (*kata apotomên ek tês apeirou*), Diogenes Laertius, IX, 31.
- 58 This is so for all of the atomists; it is also the case for Empedocles and the Stoics. See Gregory (2007).
- 59 Kahn (1960) p. 51. See below on the nature of the 'eternal motion' as well, which I argue is not chaotic.
- 60 Cf. Finkelberg (1994) p. 495.
- 61 Diogenes Laertius may not be our best witness (earth spherical, moon lit by sun) but he does get some things right as well.
- 62 McKirahan (2001) pp. 50–1.

- 63 Shortly before this, but still in the section discussing whether there is a single *cosmos*, Stobaeus, I, 22, 3a says: 'Empedocles, there is one cosmos. However, this *cosmos* is not the universe, but merely a small part of the universe. What remains is matter.' This, too, hardly inspires confidence.
- 64 See Gregory (2007) Ch. 8.
- 65 Pseudo-Plutarch, II, 4, 11 (=Aetius, II, 4, 11, DK21A37).
- 66 The key consideration is that at *Physics*, 187a12 ff. Aristotle distinguishes between those who posit a definite primary substance (one of the usual three or an intermediate between fire and air) and produce all else by rarefaction and condensation, and Anaximander (who is specifically named) who produces opposites by separation from his one.
- 67 Aristotle, *On the Heavens*, I/9, 278b8 ff.
- 68 This is Kahn's view (1960) p. 43 and p. 50. I would disagree with Kahn though that if that is the case, Theophrastus' apparent use of *cosmoi* in conjunction must be a later corruption. Anaximander may have an innocent use of *cosmoi*, or this may have been added to the oral tradition by Theophrastus, trying to explicate Anaximander further.
- 69 See later chapters for more on this distinction.
- 70 This will be argued more fully in the following chapters.
- 71 Aristotle, *On the Heavens*, I/10, 279b13 ff.
- 72 Ibid. at III/1, 298b29.
- 73 Kirk (1960) p. 29.
- 74 Mansfeld (2011) p. 15.
- 75 See Aristotle, *On Philosophy*, Fr. 19 and 20.
- 76 See Kahn (1960) p. 32 ff.
- 77 Kahn (1960) p. 34, Conche (1991) p. 101, Mansfeld (2011) pp. 6–7.
- 78 Kahn (1960) p. 51, Kirk (1955) pp. 29–30, 32. Cf. Hippolytus, *Refutation of All Heresies*, I, 14, 5 on Xenophanes.
- 79 Kahn's translation (1960) p. 85.
- 80 See Kahn (1960) pp. 84–5. The key study is Mansfeld (1971) (though see also West (1971b)). Craik (2015) has recently suggested that a fifth-century BCE date is possible.
- 81 Aristotle, *Physics*, III/4, 203b6 ff.
- 82 Ibid, at 203b27–9.
- 83 Kahn (1960) p. 35.
- 84 See Gregory (2007) Ch. 9.
- 85 Finkelberg (1994) pp. 496 and 504, cf. Engmann (1991) p. 9.
- 86 Seligman (1962) p. 127, Finkelberg (1994) p. 497.
- 87 Ibid.
- 88 Kahn (1960) p. 47.

8 The Stability of the *Cosmos*

- 1 Aristotle, *On the Heavens*, II/13, 294a28 ff.
- 2 It is inaccurate, on the indifference view, to suggest that the earth 'floats' or is 'suspended' in the middle of the *cosmos*. It does not float on anything nor is it in any way suspended. It is in the centre and has no preferred direction to move in.
- 3 Conche (1991) p. 193 note 5, Couprie (2009) p. 175.
- 4 See the photograph in Couprie (2011) p. 105.
- 5 Couprie (2009) p. 175.
- 6 In a later chapter I will argue that Anaximander was significantly influenced by architectural techniques. I believe we get a perfectly reasonable account of the heavens with the depth is one-third of the width view and have no need to employ the other view.
- 7 There is a possible Persian influence here which we will come back to in a later section.
- 8 Cf. Simplicius, *Commentary on Aristotle's on the Heavens*, VII, 511, 20–5.
- 9 The only possible evidence is if we adopt the κινεῖται reading in this passage (see previous note) but then it would be remarkable that no one in antiquity comments on Anaximander's view that the earth is in motion, especially Aristotle who one would expect to be highly critical.
- 10 Kahn (1960) pp. 55–6, cf. p. 81 note 3.
- 11 An alternative here is *huptin*, flat (Neuhauser (1883) p. 249) but this has gathered little support.
- 12 Hahn (2003) pp. 80–1.
- 13 =Aetius III, 10, 2, DK12A25.
- 14 If the ratio is one to three, as the alternative translation has it, then the problem is even more acute.
- 15 Hesiod, *Theogony*, 720–5.
- 16 The exact provenance of this tale, and indeed whether it is apocryphal, need not concern us but the essence is that in reply to the cosmologist's view that the earth is unsupported, an audience member asserted that the earth rode on the back of a giant turtle. When asked what supported the turtle, the reply is alleged to be 'that is very clever, but you can't fool me – it is turtles all the way down'.
- 17 Furley (1987) p. 25.
- 18 Ibid.
- 19 Ibid. at p. 26.
- 20 Like to like is a sorting principle whereby certain types of motion (typically vortex motion) bring like things together – there is no force in like things which draws them together. On this see Gregory (2013a) Ch. 10 and Gregory (2013b).
- 21 Furley (1989) p. 18, also see p. 18 note 29.

- 22 I would also agree with Furley (1989) p. 18 that *De Caelo*, 284a20 is an allusion to *Phaedo*, 99c such that Aristotle clearly has the *Phaedo* in mind when writing this chapter.
- 23 Furley (1989) p. 18.
- 24 For the purposes of this discussion I will assume that the celestial wheels are stable relative to the earth. There are more complex accounts of Anaximander's astronomy that we will look at later that have the sun wheel and the moon wheel in motion (up and down the axis of the *cosmos*) in order to give a better account of solstices and of their annual motions. Those motions, though, are stable in the sense that they are cyclical.
- 25 There is a complication here in that some commentators believe the wheels of the sun and moon to be in motion along the celestial axis. However, that motion is in a sense cyclical. Both sun and moon move to a maximum point 'above' the earth, then to a maximum point 'below' the earth in a determinate cycle, which in the case of the sun effectively maps out the seasons. In this sense, the celestial wheels, while in motion, are still stable in that they do not disintegrate or move off to another part of the universe.
- 26 See West (1971b) p. 92. It is not clear in West's account whether 36 is a measure of the *cosmos* or the *apeiron*.
- 27 =Aetius, II, 20, 1, DKA21. Cf. Pseudo-Plutarch, II, 21, 1 (=Aetius, II, 21, 1), Diogenes Laertius, *Lives of the Philosophers*, 2, 1–2 (DK12A1), Stobaeus, I, 25, 1c.
- 28 Stobaeus, I, 26, 1a (=Aetius, II, 25, 1), Pseudo-Plutarch, II, 25, 1 (=Aetius, II, 25, 1).
- 29 Graham (2010) translates here 'as through a jet of fire'.
- 30 Hall (1969) pp. 57–9 has suggested 'As through the funnel of a tornado' but it is hard to see how this helps with the emission of light from the rings of compressed air.
- 31 Stobaeus, I, 25, 1c, Stobaeus, I, 26, 1a, Pseudo-Plutarch, II, 21, 1, Pseudo-Plutarch, II, 25, 1, Stobaeus, I, 26, 1a, Hippolytus, *Refutation of All Heresies*, I, 6, 1–7.
- 32 Pseudo-Plutarch, II, 20, 1.
- 33 Couprie (2001b) p. 196.
- 34 LSJ.
- 35 Cf. Burnet (1930) p. 68.
- 36 LSJ.
- 37 Couprie (2001b) p. 200: 'The Arabs (tenth century AD) translated the phrase ὥσπερ διὰ πρηστήρος αὐλοῦ as "like the lightning", or more fully: "the fire comes out of them through a mouth-piece (in the same way) as the flashes of lightning appear"'
- 38 Cf. Couprie (2001b) p. 200 ff.
- 39 Kahn (1960) p. 25, Guthrie p. 93.
- 40 Wöhrle (2012) Ar. 75 prints αὐλώδεις, as does Graham (2010), cf. Conche (1991) p. 191.
- 41 Herodotus, *History*, IV, 36.

- 42 See here KRS pp. 104–5, Vlastos (1947) p. 169.
- 43 Bodnár (1988) pp. 50–1.
- 44 A possible ‘fix’ here would be that where there is an aperture, then there is some extra compressed air around it, in a manner analogous to a mechanic balancing a car wheel with a strategically placed extra weight.
- 45 See Furley (1989) p. 21. Cf. Furley (1989) p. 15, Furley (1987) p. 25.
- 46 Furley (1989) p. 21 rejects the idea of a ‘reciprocal’ parallel dynamics where, with a central earth, objects ‘above’ the earth fall ‘down’ and objects ‘below’ the earth fall ‘up’ as implausible (though I think it worth consideration) and unattested (I would agree) and also rejects the possibility of antipodeans, sometimes thought to be implied by Hippolytus’ passage, which is actually a matter of speculation.
- 47 Furley (1989) p. 17.
- 48 McKirahan (2001) pp. 64–5.
- 49 Furley (1989) p. 19.
- 50 KRS p. 134, cf. Seaford (2012) p. 60.

9 Anaximander’s Cosmology and Astronomy

- 1 It does not matter what the supposed angular size is (which is a hotly disputed topic in Anaximander) as long as we recognise that sun and moon have the same angular size (which in fact is of the order of half a degree).
- 2 Couprie (2003) p. 172. Couprie cites Boquet (1923) p. 35 and Dicks (1970) pp. 45–6.
- 3 As far as I am aware, the only modern work to discuss this is A.E. Taylor (1928), *A Commentary on Plato’s Timaeus*, pp. 236–7.
- 4 In the sense of the linear alignment of the sun, moon and earth giving identical total/partial eclipses and in the sense of the relative distances of sun and moon giving either a complete or an annular eclipse each time. There was an annular eclipse in Athens in 478 BCE.
- 5 Certainly he refers to the relation of Mercury, Venus and the sun at 38d2–6 (and quite possibly he does so at *Timaeus*, 40c8–9 as well). It is likely that *Timaeus*, 40c5 refers to retrogression, and *Republic*, 617b2 may do, though both are a matter of debate (see Heath (1913), Dicks (1970), Knorr (1990)), though it should be noted that Plato does not employ the later technical vocabulary for retrogression. He refers to eclipses and occultations at *Timaeus*, 40c3–8, and the author of the *Epinomis* is aware of the Egyptian records at 986e6–987a7 which he praises (cf. Aristotle, *De Caelo*, 270b13 ff., 292a8).

- 6 Aristotle at least sees these as important – see *De Caelo*, 292a1–8 on the moon occulting Mars, and the following comment that the Egyptians and Babylonians have records of similar events.
- 7 Plato, *Timaeus*, 40c is interesting in this respect. I would translate: ‘The dances of these stars and their juxtapositions (παραβολὰς) with one another, the circling backs and advances (ἐπανακυκλήσεις καὶ προσχωρήσεις) of their own cycles, which of the gods come into contact (συνάψεσιν) with each other and which into opposition, which cover (ἐπίπροσθεν) each other relative to us, and for what periods they each disappear and again re-appear (κατακαλύπτονται καὶ πάλιν ἀναφαινόμενα).’ I believe this shows Plato to be aware of the retrograde motion of the planets, the periods of visibility and invisibility of Mercury and Venus (an important issue in Babylonian astronomy) and the possibilities for when planets pass close to one another – they are close but both can be seen (juxtaposition) – they form a single larger image (contact) or one occludes the other (covering).
- 8 Simplicius, in *De Caelo*, 492.31 ff. Simplicius reports this challenge twice, cf. 488.18 ff.
- 9 Simplicius, in *De Caelo*, 504.17–20.
- 10 For a fuller discussion here see Gregory (2000a).
- 11 I would agree with Legatt (1995) p. 238 that Aristotle simply fails to provide a coherent solution to this problem. Cf. Gregory (2000a).
- 12 *De Caelo*, II/7 speaks quite generally of the stars, meaning all the celestial bodies, using plurals throughout, and at 298a28 refers to ‘the upper bodies which are carried in spheres’ and how their motion heats the air below them but they themselves are not ignited.
- 13 There are further issues here as well. Aristotle also argues that the moon is spherical on the grounds that the sun is crescent shaped during solar eclipse (see *De Caelo*, 291b20). On the ignition theory though, it is unclear what happens when one celestial body intervenes between another and the earth. So, too, there is a worry with Aristotle’s argument that the earth is spherical on the grounds that the moon is crescent shaped during lunar eclipses (see *De Caelo*, 298a27).
- 14 Couprie (1995) p. 159.
- 15 Couprie (2009) p. 168.
- 16 See here Couprie (2011) p. 121–2.
- 17 This is a significant issue for Couprie (see Couprie (2009) p. 167).
- 18 Couprie (2009) p. 177.
- 19 Pseudo-Plutarch, II, 20, 1, II, 21, 1, II, 25, 1, Stobaeus, I, 25, 1c, I, 26, 1a, Hippolytus, *Refutation of All Heresies*, I, 6.
- 20 Tannery (1887) pp. 91–2.
- 21 There is a textual issue with the evidence of Hippolytus, *Refutation of All Heresies*, I, 6. As printed by Diels, the text is:

Εἶναι δὲ τὸν κύκλον τοῦ ἡλίου ἑπτακαίκοσαπλάσιονα *** τῆς σελήνης, καὶ ἀνωτάτω μὲν εἶναι τὸν ἥλιον, *** κατωτάτω δὲ τοὺς τῶν ἀπλανῶν *** ἀστέρων κύκλους.

The circle of the sun is twenty seven times the moon, the highest is the sun, the lowest is the circle of the fixed stars.

Kahn (1960) prints:

Εἶναι δὲ τὸν κύκλον τοῦ ἡλίου ἑπτακαίκοσαπλάσιονα *** τῆς σελήνης, καὶ ἀνωτάτω μὲν εἶναι τὸν ἥλιον, *** κατωτάτω δὲ τοὺς τῶν ἀπλανῶν ἀστέρων κύκλους.

Some have held that the words here are all the text and there are no lacunae or mutilations, so the sun's circle is 27 times that of the moon. However, as this flatly contradicts other sources which give the sun's circle as 27 times that of the earth, this view is very much an outsider and has been superseded by a new version of the text. The standard modern text incorporates an addition:

Εἶναι δὲ τὸν κύκλον τοῦ ἡλίου ἑπτακαίκοσαπλάσιονα τῆς γῆς ὀκτωκαίδεκαπλάσιονα δὲ τὸν τῆς σελήνης, καὶ ἀνωτάτω μὲν εἶναι τὸν ἥλιον, κατωτάτω δὲ τοὺς τῶν ἀπλανῶν ἀστέρων κύκλους.

The circle of the sun is twenty seven times the earth, the moon eighteen times, the highest is the sun, the lowest is the circle of the fixed stars.

The first part of this addition to the text looks to be very sensible and is virtually beyond question. The circle of the sun is now 27 times that of the earth, which accords well with other testimony. ὀκτωκαίδεκαπλάσιονα is an interesting construction, based on a theory of how the spacing of the rings works for Anaximander, which takes in the concern that the circle of the sun is said in some sources to be 27 and in others to be 28 times the earth. Wöhrle (2012) Ar. 75 p. 64 prints:

εἶναι δὲ τὸν κύκλον τοῦ ἡλίου ἑπτακαίκοσαπλάσιονα <τῆς γῆς>, <*> τῆς σελήνης, καὶ ἀνωτάτω μὲν εἶναι τὸν ἥλιον, <*> κατωτάτω δὲ τοὺς τῶν ἀπλανῶν <καὶ πλανήτων> ἀστέρων κύκλους.

22 O'Brien (1967) p. 425.

23 Couprie (2009) p. 170.

24 I will question these assumptions in a later section.

25 O'Brien (1967) p. 424 has suggested that the cosmogony, whereby the wheels are formed from the fiery covering of the earth, indicates wheel size, but given that the wheels are many times the size of the earth and the fire would need to be radically redistributed, I am not confident we can infer anything here. I would agree with O'Brien (1967) p. 424 though that Tannery's reconstruction 'is no less intrinsically plausible than Kirk's'.

26 Kahn (1960) p. 55.

27 Ibid.

28 Ibid. at p. 88.

29 See, e.g., Sambursky (1956) pp. 15–16, West (1971b) p. 86. Though Kahn (1960) p. 62 argues that 27 must be Theophrastus' figure and that 28 is not a different measurement but is corrupt.

30 For those not familiar with this term, the fellow is the rim of a cart wheel.

31 KRS p. 136 note 1.

32 Cf. Diogenes Laertius, *Lives of the Philosophers*, 2, 1, ἀλλὰ καὶ τὸν ἥλιον οὐκ ἐλάττωνα τῆς γῆς, the sun is not smaller than the earth.

33 Naddaf () p. 17.

34 It should not be assumed here that the sun is spherical within a square cross-section of sun wheel. The height and depth of the sun are the heights and depth of the fiery core. A circular cross-section of fiery core the same diameter as the sun does not work either, as the compressed air will make the combined diameter greater than the sun's diameter.

35 This principle can be found in Rescher (1982) p. 24, O'Brien (1967) p. 424.

36 So the Tannery sequence can be saved for the diameter view of the numbers as well as the radii view of the numbers.

37 O'Brien (1967) pp. 424–5.

38 See Couprie (2011) p. 101.

39 See here diagrams in Couprie (2011) p. 102 and Hahn (2010) pp. 140–3. Note that the diagram in Couprie favours his view that the celestial wheels are deeper than they are high (see below) and that Kahn's diagrams show evidence of hollow fellows in Anaximander's time.

40 One might suggest spokes for the wheels on the basis of Achilles Tatius' report, but for sun and moon there can only be one spoke transmitting light to the earth, so even here the similarity will break down.

41 See Naddaf () p. 15 ff., and especially the diagrams on p. 16.

42 Heath (1913) p. 31 has also considered a similar idea: 'If the bore of the sun's tube were not circular but *flattened* (like a hoop), in the surface which it presents towards the earth, to several times the breadth of the sun's disc, it might be possible to explain the annual motion of the sun by supposing the opening through which the sun is seen to change its position continually on the surface of the hoop. But there is nothing in the texts to support this.'

43 Couprie (2009) pp. 179–80.

44 Cf. Kahn (1960) p. 62 who makes a similar point. The Anaxagoras passage is DK59A42.

45 See the diagram in Couprie (2011) p. 102.

- 46 It is around $\frac{1}{2}$ degree, so 720 suns or moons could be fitted on a hypothetical circular orbit, but see next section on a problem in Anaximander whereby a sun the same size as the earth on the orbit proposed would be far too big.
- 47 This simply assumes that sun and moon have the same angular width of half a degree. In fact the sun's width varies from 31.6 to 32.7 minutes, while the moon's angular width varies from 29.3 to 34.1 minutes.
- 48 There is a calculation which can be made for Couprie's model of the moon as well, similar to the one for the sun at the end of the previous section. With everything in proportion, the calculation should work pro rata, with the moon aperture slightly smaller than the height of the fiery core. However, the figures are a little more critical here if we accept the modern values of 34 minutes for the maximum angular size of the moon, slightly larger than the maximum size for the sun. A further complication here is that when the moon is seen nearer the horizon, there is an optical illusion which makes it look larger than it is, up to an angular size of $\frac{3}{4}$ of a degree. Whether Anaximander knew any of this, and whether he explained the (apparent) extra size of the moon close to the horizon as some form of illusion or by a greater opening of the moon aperture is another issue.
- 49 So one would expect some adverse comment on this in Aristotle or Theophrastus; note Aristotle's comment on Plato's *Timaeus*.
- 50 For more detail on this, see below.
- 51 Pseudo-Plutarch, *Miscellanies*, 2 (= Eusebius, *Preparatio Evangelica*, I, 8, 2), Hippolytus, *Refutation of All Heresies*, I, 6, 1–7, Stobaeus, I, 24, 1g (=Aetius, II, 13, 7).
- 52 Wöhrle (2012) Ar. 224, p. 182. This passage is not in Diels-Kranz, Mansfeld, Conche, KRS or Graham.
- 53 Kahn (1960) p. 55, p. 88.
- 54 Ibid. at p. 90, cf. Burnet (1930) p. 68.
- 55 As Kahn (1960) p. 90 puts the problem: 'Why these lower rings of stellar *aer* do not obscure the brighter but more distant bodies.'
- 56 Though one could vary the density of the air such that the star wheel air is deep but very diffuse, while the sun wheel air is shallow but very tightly packed.
- 57 Bodnár (1988) p. 50.
- 58 Burkert (1972) p. 309.
- 59 Kahn (1960) p. 90.
- 60 Dicks (1970) p. 46.
- 61 Naddaf (1988) p. 6 note 6.
- 62 Kahn (1960) p. 90.
- 63 See here Couprie (2009b) p. 262.
- 64 My thanks to Dr Tony Freith for this point.
- 65 Couprie (2009) p. 180.
- 66 Naddaf (1998) p. 14.

- 67 O'Brien (1967) p. 426.
- 68 How much this is affected by modern knowledge that the sun is, in fact, huge, though very far away, or by other modern considerations, is another issue!
- 69 The questions were 'What is the angular size of the sun?' and 'How many suns would it take to complete a circle in the sky?' Participants were asked to give their gut instincts and to give their instinctive view when they knew the real values, even if that differed.
- 70 There is a temptation sometimes to assume that once something we consider to be correct has been discovered, it was either obvious, or ought to have been obvious, to everyone who followed. This is simply not the case. Why should anyone have been convinced by Thales' estimate? That he was correct as far as we are concerned is not a sufficient explanation. Aristarchus and heliocentrism is a good example – why should anyone have been convinced by such a hypothesis in antiquity?
- 71 The text has been doubted (though only on the grounds that one-fifteenth of a zodiacal sign produces the 'wrong' result), with a substitution of a fiftieth for a fifteenth, but there context ensures that one-fifteenth was meant.
- 72 Tannery (1883) p. 241.
- 73 Heath (1913) pp. 311–12.
- 74 Geminus, *Isagoge*, I, 19–21.
- 75 The circumference escape is not available to Couprie, the main force behind the modern model, as he argues that the ratios must refer to radii, as Anaximander is giving us instructions on how to draw a map of the *cosmos*.
- 76 Cf. Stobaeus, I, 25, 1c, Pseudo-Plutarch, II, 29, 1.
- 77 Mourelatos (2015) pp. 102–3.
- 78 Cf. Pseudo-Plutarch, II, 24, 2 and Eusebius, *Preparatio Evangelica*, 15, 26, 1 who both have eclipses occurring κατὰ τὰς ἐπιστροφὰς τοῦ τροχοῦ.
- 79 Mourelatos (2015) pp. 102–3.
- 80 Ibid. at p. 103.
- 81 Ibid.
- 82 Hippolytus, *Refutation of All Heresies*, I, 6.

10 Anaximander's Numbers

- 1 See Naddaf (1988) p. 17, cf. Naddaf (2001) p. 20 note 63.
- 2 This view has been developed by Hahn (1995), (2001), (2003).
- 3 This view has been developed by Naddaf (1988).
- 4 Heath (1913) p. 38.

- 5 Even if Anaximander's numbers are not taken as a allusion to Hesiod, here is evidence that in early Greece, radius rather than diameter was the measure for the *cosmos*.
- 6 See here Couprie (2011) p. 119, Hahn (2003) p. 85 ff.
- 7 For those interested, the standard equation for terminal velocity is $v = 2mg/\rho AC_d$, where m = mass, g = gravity, ρ = density of medium, A = is the relevant area of the object and C_d is the coefficient of drag. Rather than work this out for an anvil, I have taken the terminal velocity of a bullet in free fall, to give a reasonable estimate and an easy number to work with. This figure is similar to that of a bird of prey in a hunting dive, or a human in free fall, head first and limbs in. A human falling at 90 degrees to this (as a sky diver would) has a terminal velocity of around 125 mph due to the much greater area presented.
- 8 This assumes that the space between the heaven and earth and between the earth and Tartarus is air at a density similar to that on the surface of the earth, and the time taken to reach terminal velocity is negligible relative to the time of drop (which it is) and that whatever causes the anvil to fall acts in a uniform manner between heaven and Tartarus.
- 9 Much as one might like the quirkiness of the anvil day as a measure of space, it is unlikely that it will take over from the light year as the standard measure.
- 10 Whether an anvil would actually drop more quickly than a human in free fall is a moot point, despite an inclination to believe that would be so. Modern anvils weigh roughly the same as a human (150lbs would be a reasonable anvil), and they would have roughly the same relevant area as a human falling head first. I would guess an anvil to be slightly more aerodynamic than a human, but only an empirical test would be able to sort that out for definite.
- 11 Diels, Kahn's translation, quoted in Kahn (1960) p. 94.
- 12 Hahn (2003) p. 85 has cited the example of Odysseus greeting his dog Argos after 19 years and returning home after 20 as an example of the $9 + 1$ formula being applied a second time. This may be non-symbolic or may be another form of symbolism. It is different from Anaximander though in being 19 and 20 rather than 18 and 19. It is possible that Homer thinks of this as two completed journeys on Odysseus' part (so $9 + 1$ followed by $9 + 1$), parallel to Hesiod with heaven to earth followed by earth to Tartarus. This would make Anaximander's use less radically new, but still different from Homer and Hesiod.
- 13 See Burkert (1972) p. 309 note 57.
- 14 See here Gregory (2013a) Ch. 8.
- 15 Kahn (1960) pp. 94–7.
- 16 Ibid. at p. 96.
- 17 Naddaf (1988) p. 17.
- 18 Hahn (2001) p. 9.
- 19 See Homer, e.g., *Odyssey*, I, 52 ff., *Theognis*, 869 ff., Pindar, *Olympian Odes*, 27 ff.

- 20 See West (1971b) p. 92.
- 21 Here I would agree with Naddaf (1998) p. 18 against Kahn (1960).
- 22 White (2008) p. 108.
- 23 Couprie (2011) pp. 133–4.
- 24 Hahn (2003) p. 150.
- 25 However, it must also be said that while there are 3:1 sections there are examples of many other ratios for the dimensions as well.
- 26 The term *anathurôsis* is a modern one for this technique.
- 27 Hahn (2003) pp. 80–1.
- 28 Ibid. at p. 99 ff.
- 29 See Couprie (2003) pp. 155–6.
- 30 See Hahn (2001) p. 88.
- 31 See Homer, *Odyssey*, I/53 ff., Hesiod, *Theogony*, 517 ff., Pindar, *Pythian Odes*, I/39 ff.
- 32 Cf. Couprie (2003) p. 160.
- 33 Hahn (2001) p. 188.
- 34 See Vernant (1945).
- 35 See Naddaf (2003).
- 36 Seaford (2012) p. 58.
- 37 Ibid. at p. 59.
- 38 Naddaf (1998) p. 23.
- 39 Ibid. at p. 26 note 108.
- 40 Plato, *Politicus*, 272d, 273b ff.
- 41 Parmenides, Fr. 12.
- 42 Heraclitus, Fr. 41. Cf. Heraclitus, Fr. 64: The thunderbolt steers all things.
- 43 Hippocratic author, *On Regimen*, I/10.
- 44 As one would be correct to suppose with, say, Plato's *Timaeus*.
- 45 Plato, *Timaeus*, 30a.
- 46 The sixteenth/seventeenth-century astronomer Johannes Kepler, an ardent renaissance Neoplatonist, produced a geometrical/harmonic conception of the *cosmos*. In short, he argued that there are ways of nesting the five Platonic solids together which give the ratios of the orbits of the planets and an explanation for the number of the planets (there can be no more as there are no more Platonic solids). Remarkably, the nesting produces the known ratios of the orbits of the planets within the limits of observational error for Kepler's time. Kepler further argued that we can generate ratios both from the speeds the planets have around their orbits, and from the eccentricities of their elliptical orbits. When suitably arranged and understood, these ratios represent musical notes and generate the harmony of the heavens. The issue for Kepler, as for Plato (but not modern cosmology!), is if the cosmos has been put together by a well-meaning intelligence, what criteria has that intelligence used? Again in contrast to modern cosmology, there can be no

- accidental aspects of the *cosmos* – for every aspect of the *cosmos* there is a reason why the demiurge has arranged things in this way.
- 47 Plato, *Timaeus*, 41a, cf. *Timaeus*, 32c, 38b.
- 48 Aristotle attempts to demonstrate that whatever is generated can also undergo destruction, and whatever is not generated cannot undergo destruction, and that there is nothing which is generated which is everlasting.
- 49 As I have argued elsewhere, the *Timaeus* seems to advocate a rather more stable view than some earlier works. See Gregory (2000b) Ch. 4.
- 50 Plato, *Timaeus*, 33a7.
- 51 Ibid. at 273e4.
- 52 West (1971b) p. 87.
- 53 See Chapter 8 for a discussion of this fragment.
- 54 As discussed earlier, minor variations in the sense of mountains or islands in either of these models would be of no great concern if Anaximander was not worried about minor differences upsetting the indifference arguments.
- 55 West (1971b) p. 88.
- 56 Ibid. at pp. 88–9.
- 57 Ibid. at p. 89.
- 58 See Bodnár (1988) p. 49 ff.
- 59 See West (1971b) p. 90.
- 60 Ibid.
- 61 Ibid. at pp. 93–4.
- 62 Ibid. at pp. 95–6.
- 63 So, for instance, if both the Indian and Iranian (and many more?) cultures had the idea of the cosmic egg (West (1971b) pp. 94–5), do we have to decide who had that idea first and how that idea travelled to the other cultures? Or are we allowed independent formulation of that idea?
- 64 West (1971b) p. 97.
- 65 Ibid. at p. 96.
- 66 My thanks to Dr Jason Rheins for suggesting this passage to me.
- 67 Zeyl's translation.
- 68 Cf. Couprie (2011) p. 160.

Conclusion

- 1 See Gregory (2013).
- 2 Mansfeld (2011).
- 3 Mansfeld (2009) p. 14.
- 4 Mansfeld (2011) p. 24.

5 Ibid. at p. 12.

6 Ibid. at p. 15.

7 Ibid. at p. 16.

8 See here Lloyd (1991) p. 422 and my earlier discussion.

9 Barnes (1979) p. 23.

10 See Gregory (2000).

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